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DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION
Western Region
Field Office
Rio Linda, California 95673

61308

SYSTRON DONNER

Concord Instrument Division

INSTRUCTION MANUAL

CONCORD INSTRUMENT
DIVISION

MODEL 6153

COUNTER-TIMER

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SYSTRON DONNER
CORPORATION

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ADDENDUM

MODEL 6153-50

CAUTION

IMPORTANT OPERATING INSTRUCTIONS (200 MHz to 3 GHz)

Signals to the "D" Input (50 Ω) connector MUST NOT EXCEED +20 dBm (2.2 V rms) at any time or serious (expensive) damage to the input circuit will result. Always monitor unknown signal levels first (terminated in 50 Ω), before connecting into the "D" Input of the instrument. When input levels exceed +20 dBm, insert a variable, calibrated attenuator between the signal source and the Model 6153-50.

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IMPORTANT DISASSEMBLY AND ASSEMBLY INSTRUCTIONS

A20 MIXER P.C. ASSEMBLY

Remove both top and bottom covers of the instrument. Remove top front panel trim by removing three attaching screws from behind the top of the front panel. The readout tube hold-down bracket will come off simultaneously. Remove the A15 Shifter P.C. Assembly from the Counter and unplug the A20 Mixer Cable Assembly. With long-nose pliers, reach inside the back, left-hand area of the A20 chassis housing and remove the wire routed from below the instrument by grasping the clip and pulling to the left. Remove two screws near the front panel connector. Move the A20 Assembly to the rear and tilt the back end downward. Move the cable to one side so the upper back corner of the A20 Assembly will slide into the hole with the Cable Assembly. When the input connector clears the front panel, lift the Assembly clear of the instrument. Reinstate by reversing the above procedure.
DO NOT APPLY FORCE DURING THE REMOVAL PROCEDURE AS COMPONENTS MAY BE DAMAGED.

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CHANGE THE FOLLOWING AS SHOWN:

Page 5-14, Paragraph 5.5.9.4 a)

IS:	RECYCLE RATE	Infinity
WAS:	RECYCLE RATE	Full Clockwise

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CHAPTER 1
GENERAL INFORMATION

1.1 INTRODUCTION

The Model 6153-50 Universal Counter-Timer is a general purpose instrument designed to provide the following functions:

1. Precise FREQUENCY measurements from dc to the 3 GHz region.
2. TOTALIZE (accumulating) capability to 200 MHz.
3. PERIOD and TIME INTERVAL measurements, resolution to 10 nanoseconds.
4. RATIO measurements.
5. MULTIPLE PERIOD and RATIO measurements to 10^5 for improved accuracy.
6. SCALING (frequency division) to 10^9 in decade steps.

1.2 SPECIFICATIONS

Table 1.1 lists the specifications applicable to the Model 6153-50:

TABLE 1.1 SPECIFICATIONS

FREQUENCY MEASUREMENT (RATE A)	
Range:	0 to 200 MHz (dc input).
Resolution:	1 MHz to 0.1 Hz in decade steps as selected by the front panel RESOLUTION-FREQUENCY switches.
Accuracy:	±1 count ±time base accuracy.
Readout:	"kHz" or "MHz", with positioned decimal point.
Input Signal:	"A" INPUT.
Test:	Measures 100 MHz internal standard in decade steps with RESOLUTION-FREQUENCY switches selected.
SCALING (COUNT A)	
Range:	dc to 150 MHz.
Resolution:	10 to 10^9 in decade steps as selected by the front panel SCALE-COUNT A switches.
Input Signal:	"A" INPUT.

TABLE 1.1 SPECIFICATIONS (Cont'd)

SCALING (COUNT A) Cont'd	
Output:	At Time Base/SCALE OUTput connector.
TIME INTERVAL (TIM B-C)	
Range:	100 ns to 10^8 seconds.
Resolution:	10 ns to 1 second in decade steps as selected by the front panel RESOLUTION-TIME switches.
Accuracy (Pulse):	±1 period of the selected frequency counted ±time base accuracy.
Readout:	Seconds, milliseconds, microseconds, with positioned decimal point.
Input Signals:	"B" INPUT and "C" INPUT.
PERIOD (PERIOD B)	
Range:	Single period, dc to 10 MHz. Multiple period, dc to 10 MHz.
Periods Averaged:	1 period to 10^5 periods, in decade steps.
Frequency Counted:	Single and multiple, 100 MHz to 1 Hz, in decade steps.
Accuracy:	±1 count ±time base accuracy ±trigger error*.
Readout:	Seconds, milliseconds, microseconds, with positioned decimal point.
Input Signal:	"B" INPUT.
Test:	Tests operation, 1 period to 10^5 periods.
RATIO (RATIO A/B x M)	
Displays:	"A" Input/"B" Input times selected multiplier (multiplier = 1 to 10^5).
Range:	"A" INPUT: dc to 200 MHz. "B" INPUT: 0 to 10 MHz (single or multiple ratio; ratios averaged 1 to 10^5 in decade steps).

TABLE 1.1 SPECIFICATIONS (Cont'd)

RATIO (RATIO A/B x M) Cont'd	
Accuracy:	±1 count of "A" INPUT ±trigger error* of "B" INPUT.
Readout:	Dimensionless (positioned decimal point for number of ratios averaged).
Input Signals:	"A" INPUT (Numerator); "B" INPUT (Denominator).
Test:	Same as Period Averaged test.
FREQUENCY MEASUREMENT (RATE D)	
Range:	200 MHz to 3 GHz.
Type Signal:	CW.
Resolution:	1 MHz to 0.1 Hz, in decade steps.
Accuracy:	±1 count ±time base accuracy.
Readout:	"kHz" or "MHz" with positioned decimal point.
Input Signal:	"D" INPUT.
GENERAL	
Display:	8 digits in-line; 99,999,999 maximum display.
Storage:	Provides continuous display of most recent measurement; rear panel switch overrides storage feature.
Gate Light:	Provides visual indication of main-counter gate operation.
Off Scale Light (OS):	Provides visual indication when display register has been exceeded.
Invalid Switch Position Light (*):	Lights when FUNCTION and RESOLUTION switches are in unallowable positions.
Recycle Rate:	Controls time from end of measurement to the start of new measurement. In SLOW position, variable from less than 60 milliseconds to more than 5 seconds. In FAST position, variable from less than 500 microseconds to more than 60 milliseconds.

TABLE 1.1 SPECIFICATIONS (Cont'd)

GENERAL Cont'd	
Reset:	Front panel pushbutton clears counter and resets display to zero.
"A" INPUT	
Sensitivity:	100 mV rms.
Input Impedance:	1 MΩ shunted by less than 25 pF.
Coupling:	DC or AC, selected by front panel switch.
Attenuation:	Step attenuator by factors of 1, 10, or 100.
Trigger Level:	±1 V x attenuation factor. A "Preset" position centers the trigger level to approximately 0 V.
Overload:	Overload without damage is provided: a) 120 V rms in the x 1 position (<1 kHz). b) 250 V rms in the x 10 position. c) 500 V rms in the x 100 position.
Connector:	BNC type.
"B" INPUT AND "C" INPUT	
Sensitivity:	0.3 V p-p.
Input Impedance:	1 MΩ shunted by less than 35 pF, for input voltages up to three times the attenuator setting.
Coupling:	DC or AC, selected by front panel switch.
Attenuation:	Step attenuators by factors of 1, 10, or 100.
Trigger Level:	Adjustable 3.0 V x attenuation factor. A "Preset" position centers the trigger level to approximately 0 V.

TABLE 1.1 SPECIFICATIONS (Cont'd)

"B" INPUT AND "C" INPUT Cont'd

Overload:	Overload without damage is provided: a) 120 V rms in the x 1 position (<1 kHz). b) 250 V rms in the x 10 position. c) 500 V rms in the x 100 position.
Trigger Slope:	POSITIVE or NEGATIVE on Start and Stop inputs, independently selectable.
Separate-Common:	Independent or common channels referred to "B" INPUT.
Connector:	BNC type.

"D" INPUT

Sensitivity:	-13 dBm (50mV rms) minimum.
Impedance:	50 Ω nominal.
Type Signal:	CW.
Overload:	Maximum level without damage, +20 dBm (2.2 V rms).
Connector:	Type N.

EXT/INT STANDARD FREQUENCY INPUT

Input:	A 1 V rms signal into 1 kΩ from an external frequency standard can be used if harmonically related to 10 MHz (100 kHz to 10 MHz). For example; 100 kHz, 250 kHz, 500 kHz or 1 MHz signals can be used (INT/EXT switch).
Connector:	BNC type.

EXT/INT TIME BASE

Input:	A 1 V rms signal into 1 kΩ provides access to the internal Time Base for manual conversion to other units of measure (10 kHz to 10 MHz). Switch selectable (INT/EXT switch).
Connector:	BNC type.

TABLE 1.1 SPECIFICATIONS (Cont'd)

"B" AND "C" MARKER OUTPUTS	
Outputs:	Coincide with Start-Stop triggering of the waveform being measured.
Amplitude:	> 10 V p-p.
Source Impedance:	< 1.5 kΩ.
Pulse Width:	< 1.5 microsecond.
Connector:	BNC type.
GATE OUTPUT	
Output:	Coincides with main counter gate operation.
Amplitude:	> +2.5 V = 1 state (gate open - counting). < +0.8 V = 0 state (gate closed - not counting).
Source Impedance:	TTL output.
Connector:	BNC type.
TIME BASE/SCALE OUT	
Output:	Provides output frequencies of 0.1 Hz to 10 MHz selected by front panel resolution switches in the Rate, Period, Tim, and Ratio modes.
Amplitude:	> 1 V p-p.
Source Impedance:	TTL output.
Connector:	BNC type.
BCD OUTPUT	
Output:	Four line BCD 1-2-4-8, all indicators, decimals and measurement units. "1" state level: > +3.5 V. "0" state level: < +0.8 V.
Impedance:	TTL output.
Reference Levels:	Positive reference, +5 V through 1 kΩ; negative reference, ground.

TABLE 1.1 SPECIFICATIONS (Cont'd)

BCD OUTPUT Cont'd	
Print Command:	+12 V to 0 V step. 1 kΩ source, dc-coupled. Also, 0 V to +12 V step.
Hold Off Requirement:	$\leq$ 0 V to +0.8 V to inhibit instrument; > +1.8 V to enable.
Connector:	Amphenol 50-pin 57-30500-375.
TIME BASE	
Crystal Frequency:	3 MHz.
Aging Rate:	< 3 parts in 10^9 per day after 72 hours of continuous powered operation.
Short Term:	< 2 parts in 10^{10} rms with measurement averaging time of one second while under constant environment and line conditions.
Temperature:	< ±2 parts in 10^{10} per degree centigrade from -10°C to +50°C.
Line Voltage:	< ±5 parts in 10^{10} for a ±10% change in line voltage.
Adjustment:	±5 x 10^6 coarse; >±4 x 10^8 fine, with a setting resolution of ±1 x 10^9 on the fine adjust.
Retrace:	For "Off" periods up to 24 hours; < ±1 part 10^6/hour after 1/2 hour operation. < ±1 part 10^7/hour after 1 hour operation. < ±5 parts 10^9/hour after 2 hours operation.
**TRIGGER ERROR:*	*Trigger error is less than 0.3% of one period divided by the number of periods averaged for a 100 mV rms signal with a > 40 dB signal to noise ratio. Error is less with a signal of greater amplitude or improved signal to noise ratio.*
OPERATING TEMPERATURE RANGE	0°C to +50°C.

TABLE 1.1 SPECIFICATIONS (Cont'd)

RELATIVE HUMIDITY	10% to 80%.
AC LINE VOLTAGE	115 V rms or 230 V rms, ±10%, 75 W.
AC LINE FREQUENCY	60 Hz, ±2 Hz.

1.3 DEFINITIONS

1) Aging Rate

Defines the average slope of the fractional frequency change of an oscillator plotted against time (see Figure 1.1).

2) Positive Logic

Activation or true indication takes place when signal changes from low level to high level (see Figure 1.2).

3) Negative Logic

Activation or true indication takes place when signal changes from high level to low level (see Figure 1.2).

1.4 APPLICATION

The Model 6153-50 Universal Counter-Timer measures frequencies from 0 to 3 GHz. It can be employed for measurement, analysis, and counting of both periodic and random signals of various waveforms within the rated frequency characteristics of the instrument. Because it operates directly from voltage inputs, it is an indispensable tool for designing, manufacturing, and testing of instruments/circuits having electrical outputs relating to time interval, frequency, or number of occurrences. It is commonly used for the design and calibration of transmitting and receiving equipment, oscillators, tuned circuits, crystals, etc. Because of its accuracy and stability, it is invaluable for checking long term drift and heat-cycling stability of crystals and other signal generators. Other common applications are calibration of resolvers and synchros.

When driven from suitable input tranducers such as photo cells, magnetic pickups, or switches, it becomes equally valuable for measuring physical events with respect to time. For example; speed of rotation, flow rate, time delays, or production unit counting are just a few to be considered. In addition, other typical applications include, frequency measurements, relay and switch timing, ballistic measurements, etc.

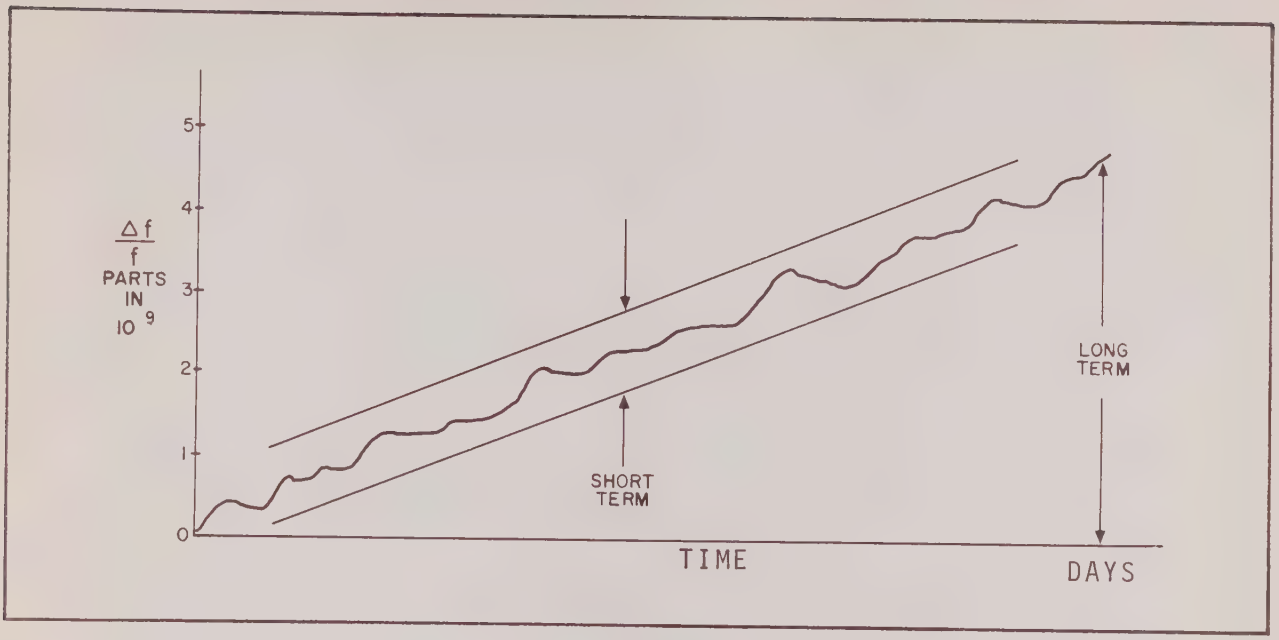


FIGURE 1.1 AGING RATE OF OSCILLATOR

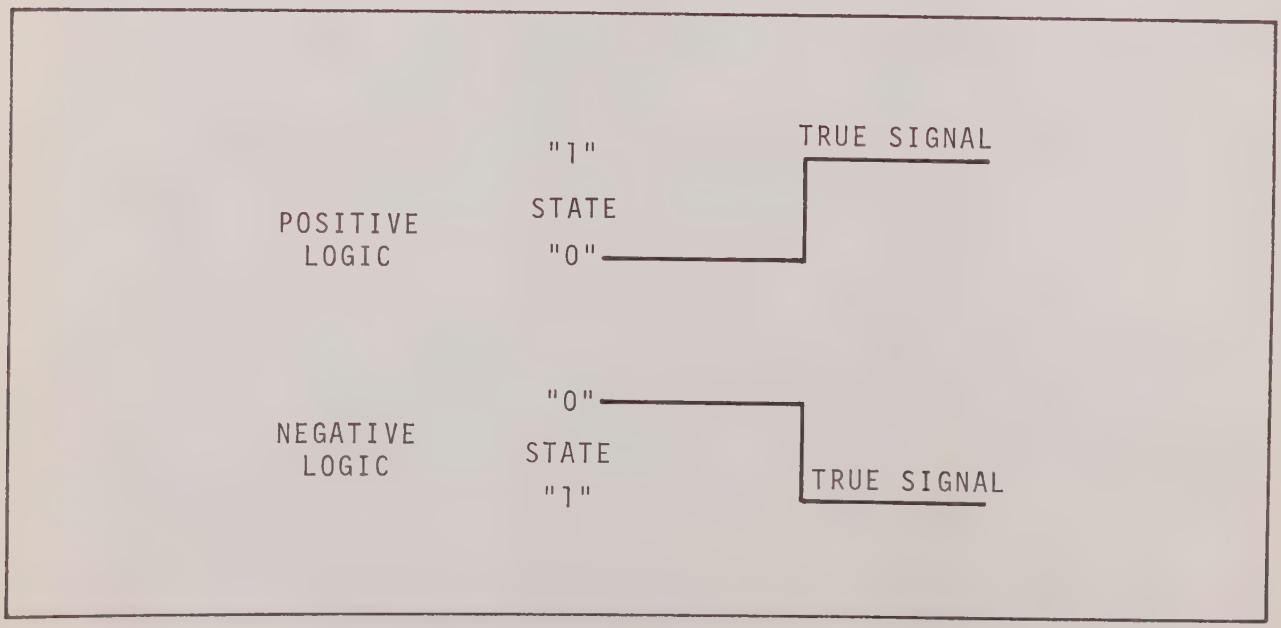


FIGURE 1.2 DEFINITION OF LOGIC LEVELS

CHAPTER 2
INSTALLATION

2.1 INTRODUCTION

The Model 6153-50 Universal Counter-Timer is shipped in an operational condition, and is essentially ready for use, as received. This section contains unpacking, inspection, and installation information to aid in setting up the instrument for immediate use.

2.2 RECEIVING INSPECTION

As soon as the instrument is received, check the carton for evidence of damage or rough handling. If damage is found, or is suspected, notify the carrier and your Systron-Donner Representative. Open the shipping container only in their presence.

Use care in removing the instrument from the container. Check immediately for loose or broken control knobs, bent or broken connectors, and dents or scratches on the panel surfaces. If damage of any nature is found, refer to the warranty instructions in the front of this instruction manual.

All Systron-Donner instruments must pass rigid inspection tests before leaving the plant. However, upon receipt, a receiving inspection test should be performed immediately after unpacking to ensure that the instrument is still operational.

2.3 INSTALLATION

2.3.1 Power

The instrument is provided with a 3-conductor power cord which grounds the case when connected through a compatible grounding outlet. If a standard ground outlet is not available, a 3-conductor adapter must be used which provides the necessary grounding connection. Make sure the rear panel 115-230 V switch is in the correct position before connecting the instrument to a power source. Also, be certain that the proper fuse F1 is installed (1 ampere, 115 V ac; .5 ampere, 230 V ac).

2.3.2 Cooling

The Model 6153-50 design incorporates a cooling fan. Cooling air enters the case at the front of the instrument, passing through the internal assemblies; then, exhausts through the fan in the rear panel. Care must be exercised not to obstruct the flow of air into or out of the instrument case, especially when the instrument is resting flat on the bumper feet (tilt stand folded up or removed).

NOTE

If the instrument is to be rack or console-mounted, determine if the stand/bumper feet will interfer; then, remove these items as required. Remove side-dress panel for maximum ventilation.

2.4 STORAGE AND RESHIPMENT

Environmental conditions during storage and shipment should be limited to a maximum temperature of 85°C and a minimum temperature of -55°C.

To protect the instrument during shipment or storage, use the best packaging methods available. Contact the nearest Systron-Donner field office for materials similar to those used in the original factory package. Contract packaging companies are also available to provide dependable custom-packaging service on short notice.

1) If possible use the original shipping container designed for the instrument. Otherwise, a strong carton (350 lb f/in^2 bursting strength) or wooden box should provide adequate protection.

2) Wrap the instrument in heavy paper or plastic before placing it in the shipping container.

3) Completely fill the area around the instrument with packing material; protect the front panel surfaces with several sheets of cardboard.

4) Seal the package with strong tape or metal bands. Mark FRAGILE - DELICATE INSTRUMENT on the outside of package.

5) Refer to the Warranty in this manual and check with the nearest Systron-Donner field office for shipping instructions. In all correspondence, refer to the instrument by full model number and serial number.

CHAPTER 3

OPERATION

3.1 ACCURACY OF MEASUREMENTS

3.1.1 Gating Ambiguity

All types of digital measuring instruments are subject to an irreducible ±1 count ambiguity in the least significant digit of the display. This error is possible because the signal counted is not coherent (synchronized) with the time base pulses that control the signal gate. As illustrated in Figure 3.1, the first or last cycle of the input signal may, or may not, pass through the signal gate during the selected measurement interval.

As the measured frequency is increased, the percent of error due to the ±1 count ambiguity is reduced since it becomes less significant compared to the total count. In any case, the maximum percentage of error is a function of the frequency measured and the number of pulses counted; i.e., the time base selected, and may be expressed by:

$$\text{Max \% error} = \pm \frac{1}{fxT} \times 100 \leq 100\%$$

where: f is the frequency measured in Hz and T is the selected time base in seconds. Thus to measure 1 MHz with a ±0.001% maximum gating error, the RESOLUTION-FREQUENCY switch must be set to the 10 Hz position.

3.1.2 Internal Oscillator Stability

The gating precision, and therefore the accuracy of the count, is dependent upon the stability of the internal oscillator.

In the standard instrument, the oscillator is initially set to within ±1 part in 10^9 of a 1 MHz frequency standard having at least an order of magnitude higher stability.

Deviation of the Model 6153-50 oscillator from this frequency then becomes a function of several factors; the most significant being time. Due to certain processes in the frequency determining elements of the oscillator, an "aging" rate is established that can be measured and specified for the oscillator. This aging rate is specified to be less than ±3 parts in 10^9 per day after an initial warm-up of 72 hours. Generally, this aging rate decreases with time (providing the instrument remains continuously energized). The error due to oscillator instability may be estimated from:

$$\text{Max \% error} = (\pm 3/10^9 \times D) \times 100$$

where: D is the number of days since last calibrated.

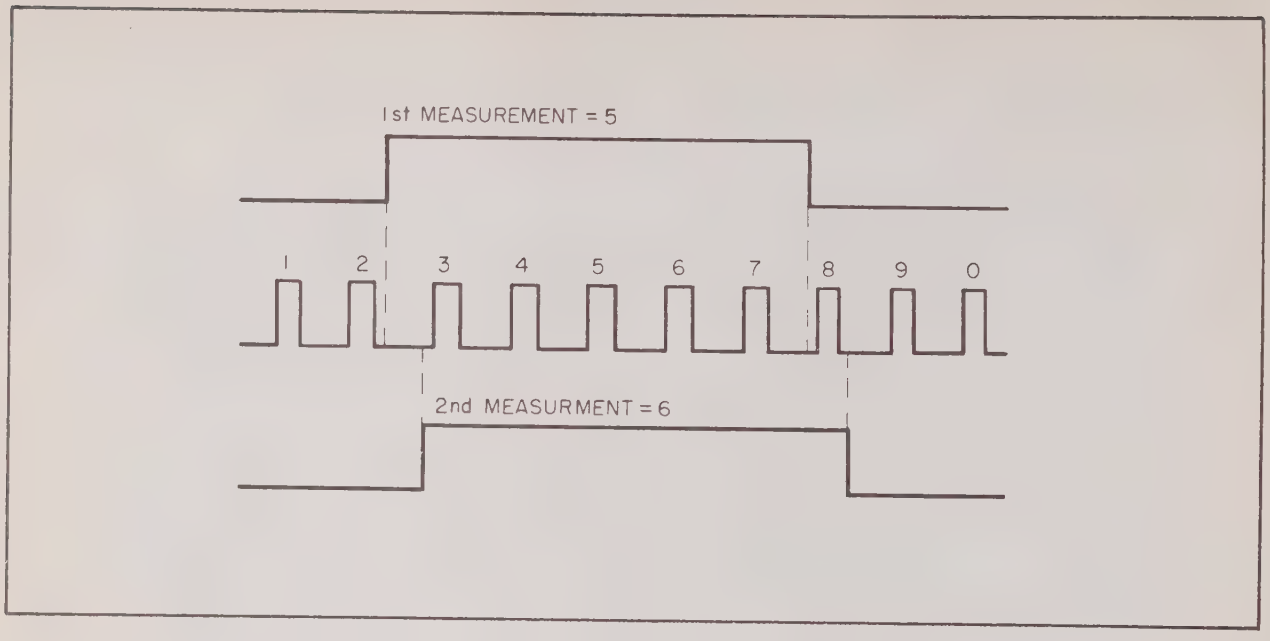


FIGURE 3.1 GATING AMBIGUITY.

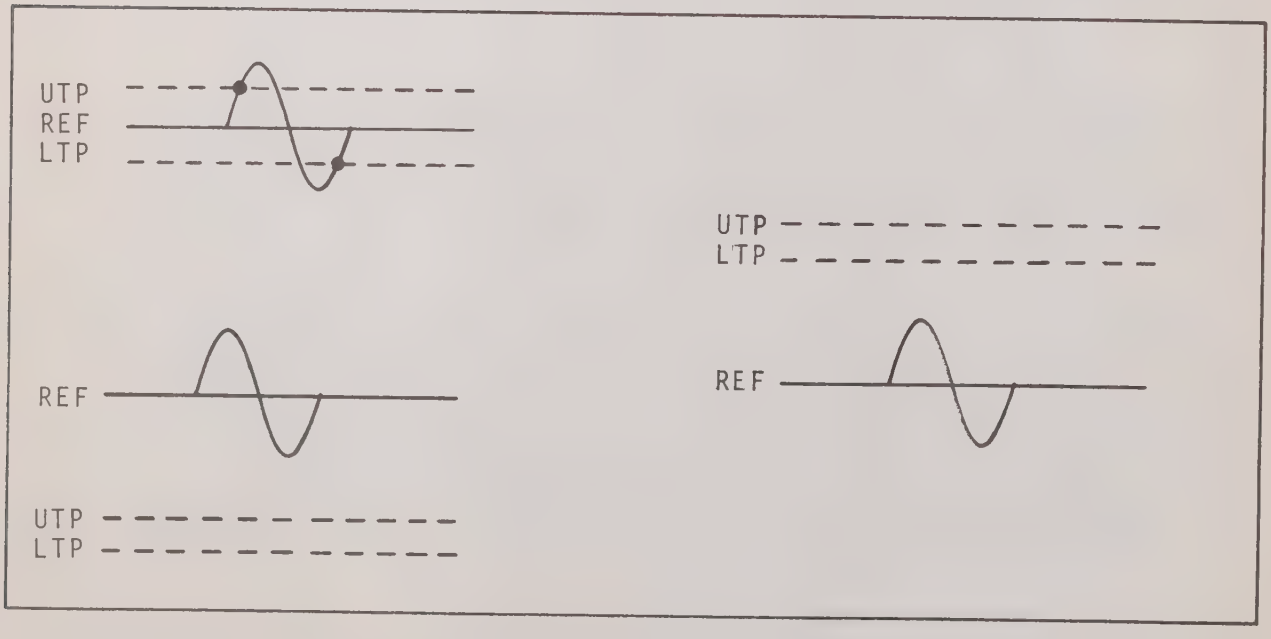


FIGURE 3.2 TRIGGERING LEVELS.

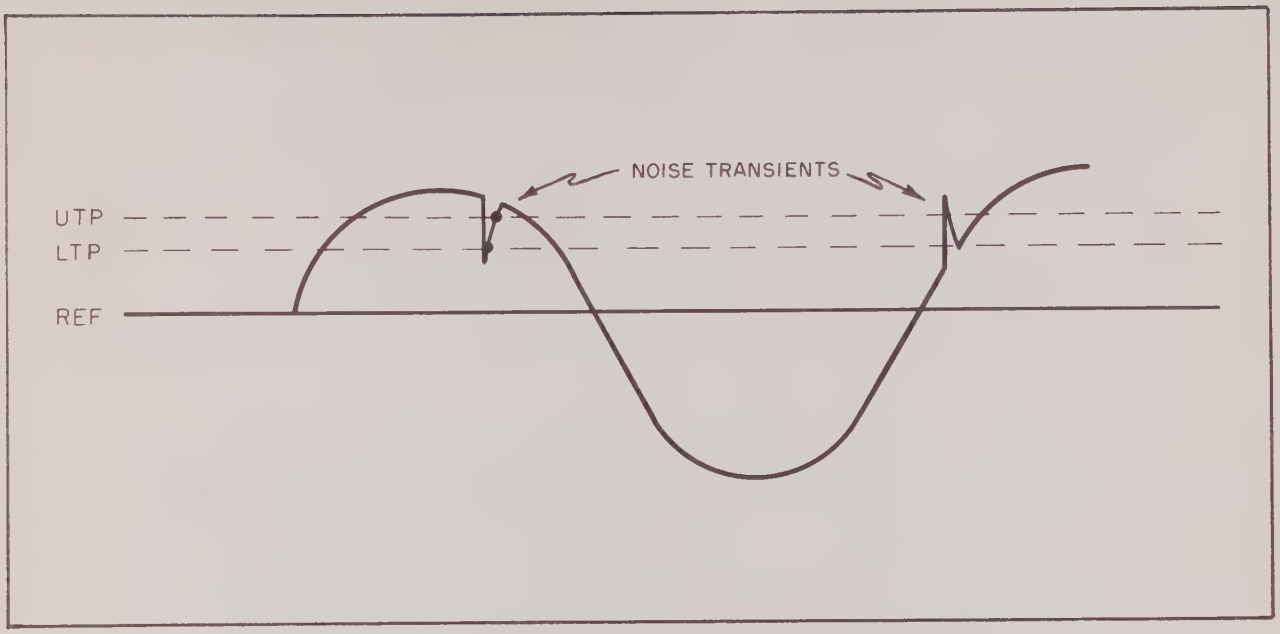


FIGURE 3.3 SPURIOUS COUNTS DUE TO NOISE TRANSIENTS.

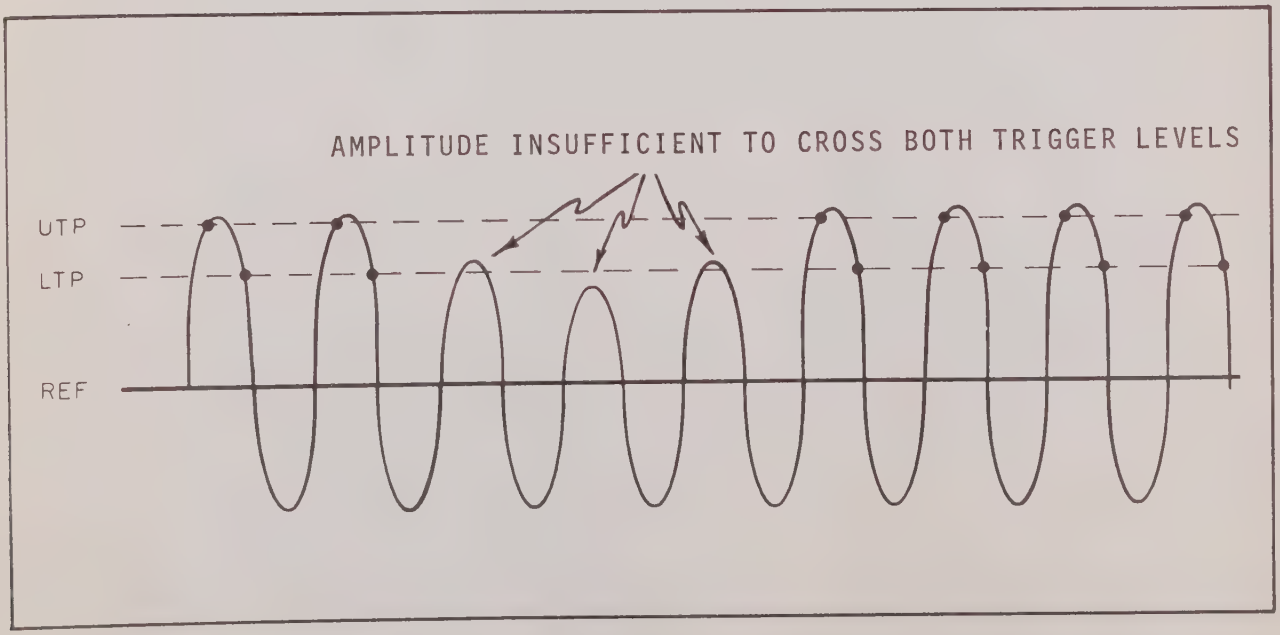


FIGURE 3.4 MISSING COUNTS DUE TO AMPLITUDE MODULATION.

Oscillator stability is also a function of line voltage and temperature; except for the time immediately after calibration, their effect will be several orders of magnitude less than the effect of aging and may be neglected. To achieve the highest accuracy of measurement, the following considerations apply:

1) Maintain the instrument plugged-in and continuously energized.

2) Maintain constant environmental conditions.

3) Monitor or regulate line voltage.

4) Calibrate instrument at intervals consistent with maximum allowable error.

3.1.3 Level Control Adjustment

Unstable and inaccurate measurements often result from inconsistent triggering of the signal processing circuits. In many cases, this is due to improper adjustment of the LEVEL control for the type of signal being handled. Figure 3.2 illustrates the nominal input triggering level and the effect of the LEVEL control. Note that there is a 0.3 V nominal separation (or hysterisis) between the upper and lower trigger levels; and in operation, the input signal must cross both levels to complete a triggering cycle. The LEVEL control acts to offset the reference level of the input signal.

Generally, the setting of the LEVEL control for sinusoidal inputs should be made at approximately the center of the steepest slope on the input waveform to ensure reliable counting. However, careful attention must be paid to the amplitude/shape of the input signal when non-sinusoidal, unknown, or marginal signals are being measured. It is recommended that an oscilloscope be utilized for signal analysis under these conditions. Figures 3.3 thru 3.6 illustrate a variety of situations leading to inaccurate counting and some possible solutions.

1) PROBLEM:

Spurious counts from superimposed noise transients of sufficient amplitude to cross trigger levels (see Figure 3.3).

POSSIBLE SOLUTIONS:

a. Adjust LEVEL control for triggering on steepest portion of signal slope.

b. Provide attenuation (either internal or external) to reduce noise peaks below trigger hysterisis (0.3 V).

c. Connect low pass filter between signal source and instrument input.

2) PROBLEM:

Missing count due to amplitude modulation of input signal (see Figure 3.4).

POSSIBLE SOLUTION:

a. Adjust LEVEL control for triggering on steepest portion of slope. Signal amplitude in modulation

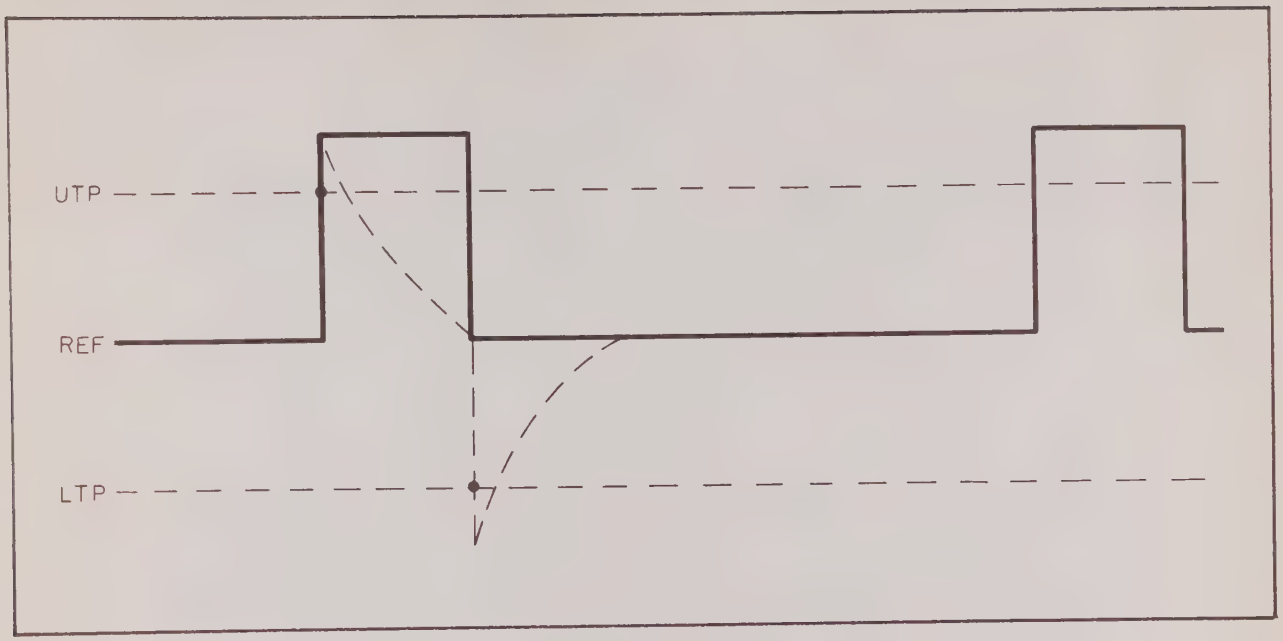


FIGURE 3.5 MONOPOLAR PULSES INTERSECTING ONLY ONE TRIGGER LEVEL.

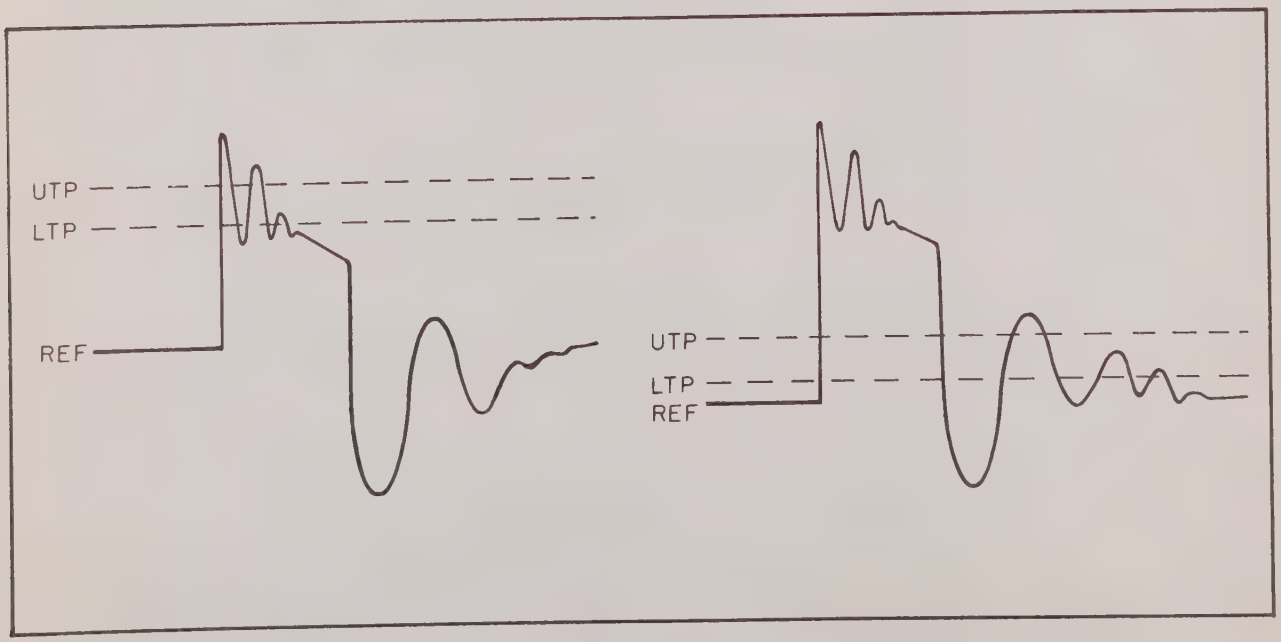


FIGURE 3.6 RINGING ON PULSE WAVEFORM CAUSES COUNT ERROR.

trough must be sufficient to cross both trigger levels.

3) PROBLEM:

Monopolar pulses intersect only one triggering level (see Figure 3.5).

POSSIBLE SOLUTIONS:

a. Offset LEVEL control so that pulses intersect both levels. Pulse amplitude must be greater than hysterisis value (0.3 V).

b. Externally differentiate the pulses.

4) PROBLEM:

Ringing on leading and trailing edges of signal pulse. Usually a result of mismatch between instrument input and signal source when source impedance is 50 or 75 Ω (see Figure 3.6).

POSSIBLE SOLUTION:

a. Properly terminate input signal cable at INPUT connector on front panel of instrument (usually a 50 or 75 Ω termination in shunt with INPUT).

3.1.4 Period Measurements

For high frequency measurements, the ±1 count gating error is insignificant compared to the total count. At low frequencies, however, the error may become important. For this reason the period mode of measurement is normally used to obtain greater accuracy. Figure 3.7 shows which type of measurement will yield the lowest gating error.

Gating error can be reduced by a factor of 10 or more by extending the interval of measurement (Period X10, etc). The total count is multiplied by 10^n, but the gating error in each case remains ±1 count.

For example, if a 10 kHz signal is measured over a 0.1 second time base, the count indicated would be 1000 ±1 and the percentage of error would be ±0.1%. Measured over a 1 second time base, the count indicated would be 10000 ±1 and the percentage of error would be reduced to ±0.01%.

Period and related time-interval measurements are subject to a trigger time-error caused by noise on the input signal (see Figure 3.8). The total signal may be considered as an ideal noise-free signal with a superimposed noise component. The noise, added to the ideal signal, may trigger the channel before or after the selected instant for triggering. The maximum error in time for a given peak-to-peak noise voltage on the slope of an ideal signal at the trigger level is:

$$t = \frac{Vn}{S}$$

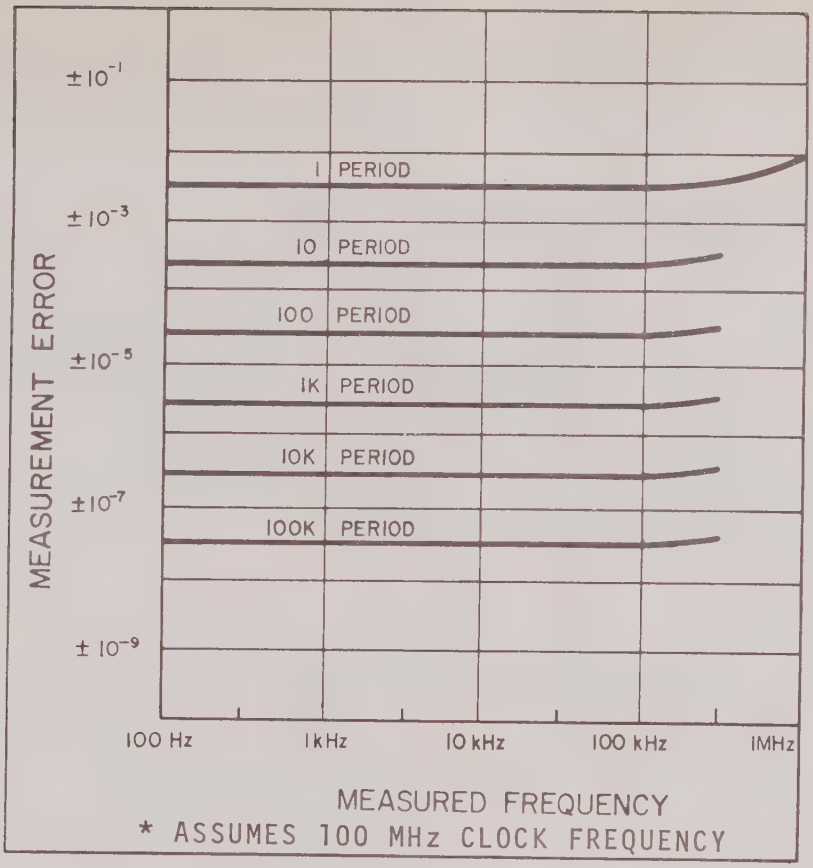


FIGURE 3.7 PERIOD MEASUREMENT ERROR

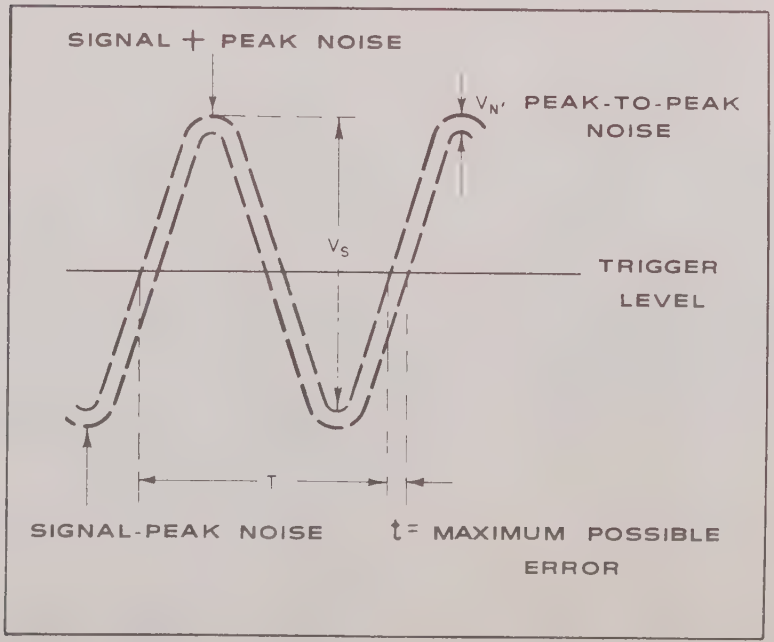


FIGURE 3.8 PERIOD AND TIM TRIGGERING ERROR CAUSED BY SIGNAL NOISE.

The maximum percent error is:

$$\text{Max. \% error} = \frac{t \times 100}{T}$$

For a sine wave triggering at its zero cross-over point:

$$\text{Max. \% error} = \frac{Vn \times 100}{Vs}$$

Where:
- t = maximum trigger error (seconds).
- Vn = peak-to-peak noise (volts).
- S = slope of ideal signal (volts/second).
- T = actual period of signal (seconds).
- Vs = peak-to-peak signal (volts).

3.2 CONTROLS, CONNECTORS AND INDICATORS

3.2.1 Front Panel

Front panel control functions for the Model 6153-50 are described in this section as follows (see Figure 3.9):

1) POWER (Toggle Switch):	Applies ac power to instrument.
2) TEST (Pushbutton):	Test instrument in Rate A, Ratio, Period, Count, and Rate D.
3) RESOLUTION (Pushbuttons):	Selects time base and clock frequencies, dependent on function.
4) RESET (Pushbutton):	Resets display to zero.
5) FAST-SLOW (Slide Switch):	Selects range of Recycle Rate control.
6) RECYCLE RATE (Potentiometer/Switch)	Varies sample rate of instrument.
7) FUNCTION (Rotary Switch):	Selects major measurement function to be performed.
8) "A" INPUT (Connector, BNC):	Connects input signal for Rate A, Count, Scale and Ratio numerator.
9) DC-AC (Slide Switch):	Selects dc or ac coupling to "A" INPUT amplifier.
10) ATTENUATOR (Slide Switch):	Selects attenuation factor for "A" INPUT amplifier.
11) LEVEL (Potentiometer/Switch):	Adjusts trigger level for "A" INPUT amplifier.

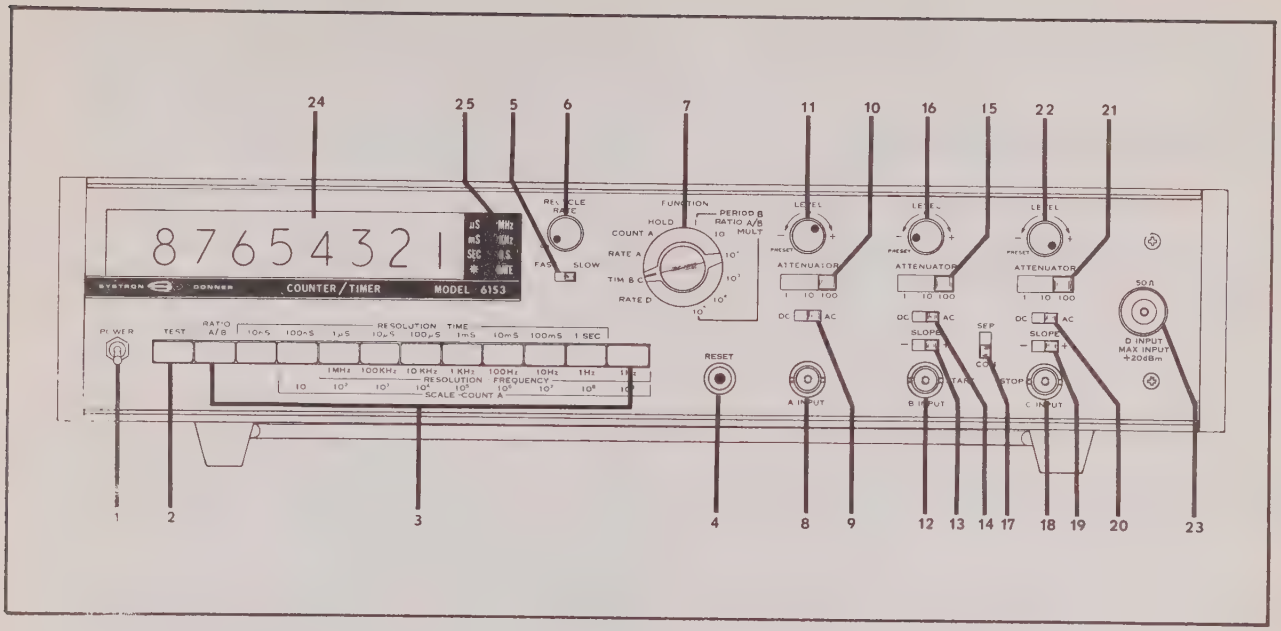


FIGURE 3.9 FRONT PANEL CONTROLS, CONNECTORS, AND INDICATORS.

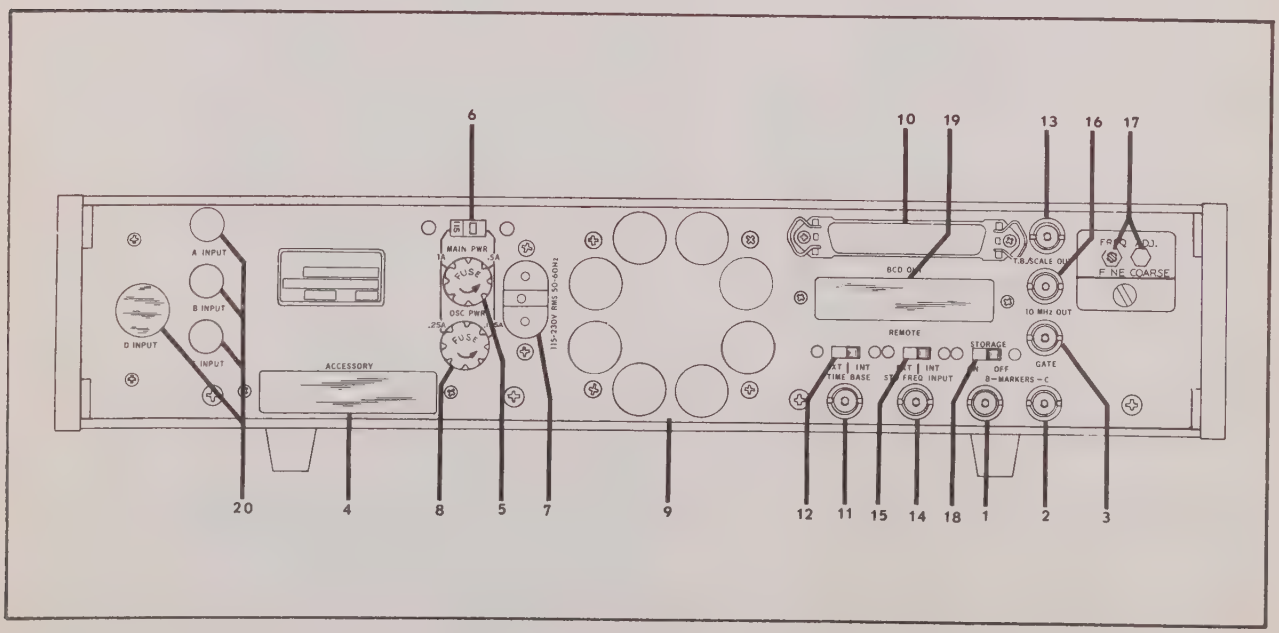


FIGURE 3.10 REAR PANEL CONTROLS, INPUTS, AND OUTPUTS.

12)	"B" INPUT (Connector, BNC):	Connects input for Period and Multiple Period, Ratio denominator, and TIM start.
13)	SLOPE (Slide Switch):	Selects triggering polarity of "B" INPUT Signal.
14)	DC-AC (Slide Switch):	Selects dc or ac coupling to "B" INPUT amplifier.
15)	ATTENUATOR (Slide Switch):	Selects attenuation factor for "B" INPUT amplifier.
16)	LEVEL (Potentiometer/Switch):	Adjusts trigger level for "B" INPUT amplifier.
17)	SEPARATE-COMMON (Slide Switch):	Connects "B" INPUT amplifier and "C" INPUT amplifier in parallel through the "B" INPUT connector; simultaneously disconnects the "C" INPUT connector. When set to the Separate position, "B" INPUT and "C" INPUT are isolated.
18)	"C" INPUT (Connector, BNC):	Connects Stop signal for TIM.
19)	SLOPE (Slide Switch):	Selects triggering polarity of "C" INPUT signal.
20)	DC-AC (Slide Switch):	Selects dc or ac coupling to "C" INPUT amplifier.
21)	ATTENUATOR (Slide Switch):	Selects attenuation factor for "C" INPUT amplifier.
22)	LEVEL (Potentiometer/Switch):	Adjusts trigger level for "C" INPUT amplifier.
23)	"D" INPUT (Connector, Type N):	Connects input signal for RATE "D" measurements.
24)	READOUT INDICATORS:	8-digit in-line, 99,999,999 maximum display.
25)	READOUT ANNUNCIATOR:	Indicates units of measurement; µS, mS, SEC, *(Invalid Switch position), MHz, KHz, O.S. (Off Scale), and GATE.

3.2.2 Rear Panel

Rear Panel control functions for the Model 6153-50 are described in this section as follows (see Figure 3.10):

1)	"B" MARKER (Connector, BNC):	Provides signal for oscilloscope triggering or modulation.
2)	"C" MARKER (Connector, BNC):	Provides signal for oscilloscope triggering or modulation.
3)	GATE (Connector, BNC):	Main count gate output.
4)	ACCESSORY (Cover Plate):	Optional equipment.
5)	FUSE (Holder):	Main power fuse F1 (1 ampere, 115 V ac, .5 ampere, 230 V ac).
6)	MAIN POWER 115 V/230 V (Switch):	Adapts instrument to 115 V ac or 230 V ac power input.
7)	POWER CORD (Receptacle):	Connects to main line-power (115/230 V ac, 50/60 Hz).
8)	FUSE (Holder):	Oscillator power supply fuse F2 (.25 ampere, 115/230 V ac).
9)	FAN:	Cooling for internal components and assemblies.
10)	BCD OUT (Connector, 50 Pins):	Provides BCD output for digital recorder.
11)	EXT/INT TIME BASE (Connector, BNC):	Provides external access to instrument Time Base for manual conversion to other units of measure (frequencies 10 kHz to 10 MHz). Operating mode (EXT/INT) selected by slide switch.
12)	EXT/INT TIME BASE (Slide Switch):	Selects external or internal frequency for time base (see Item 11 above).
13)	TIME BASE SCALE OUTPUT (Connector, BNC):	Provides time base or divided frequency as set by Resolution & Function switches.
14)	EXT/INT STD. FREQUENCY INPUT (Connector, BNC):	Accepts frequency standard signals which are harmonically related to 10 MHz. Operating mode (EXT/INT) selected by slide switch .

TABLE 3.1A BCD OUTPUT PIN ASSIGNMENTS

Numerical Indication on Counter	BCD	PIN
10^0	1	1
	2	2
	4	26
	8	27
10^1	1	3
	2	4
	4	28
	8	29
10^2	1	5
	2	6
	4	30
	8	31
10^3	1	7
	2	8
	4	32
	8	33
10^4	1	9
	2	10
	4	34
	8	35

Numerical Indication on Counter	BCD	PIN
10^5	1	11
	2	12
	4	36
	8	37
10^6	1	13
	2	14
	4	38
	8	39
10^7	1	15
	2	16
	4	40
	8	41

ANNUNCIATOR	1	17
	2	18
	4	42
	8 (Gnd)	43

ANNUNCIATOR TRANSLATIONS

Measurement:	*	= Binary 0
	MHz	= Binary 1
	KHz	= Binary 2
	sec	= Binary 3
	ms	= Binary 4
	us	= Binary 5

DECIMAL POINT	1	19
	2	20
	4	44
	8	45

DECIMAL TRANSLATION

Readout Location	10^0	= Binary 0
	10^1	= Binary 1
	10^2	= Binary 2
	10^3	= Binary 3
	10^4	= Binary 4
	10^5	= Binary 5
	10^6	= Binary 6
	10^7	= Binary 7

RECORDER CONTROL	
+ Reference	25
- Reference	24
Instrument Gnd	50
+ Print Command	23
Reset Inhibit	47
- Print Command	48
Inhibit Store	46

TABLE 3.1B
REMOTE PROGRAMMING PIN ASSIGNMENTS
(Single Line Selection - Grounded Line True)

Pin No.	Function	Pin No.	Function	
1	Test	25	Attenuator X1	
2	Ratio	26	Attenuator X10	
3	10ns	27	Attenuator X100	"A" Amp.
4	100ns	28	Coupling DC	
5	1µs	29	Attenuator X1	
6	10µs	30	Attenuator X10	
7	100µs	31	Attenuator X100	"B" Amp.
8	1ms	32	Coupling DC	
9	10ms	33	Slope Negative	
10	100ms	34	Attenuator X1	
11	1s	35	Attenuator X10	
12	.1Hz	36	Attenuator X100	"C" Amp.
13	Fast Recycle	37	Coupling DC	
14	TIM	38	Slope Negative	
15	Rate D	39	Common "B" & "C" Amplifiers	
16	Rate A	40	Demand Reset	
17	Count A	41	No Connection	
18	Hold	42	No Connection	
19	P/R x 1	43	No Connection	
20	P/R x 10	44	No Connection	
21	P/R x 10^2	45	No Connection	
22	P/R x 10^3	46	No Connection	
23	P/R x 10^4	47	Remote Control Amplifiers	
24	P/R x 10^5	48	Remote Control Function & T.B.	
		49	Ground	
		50	Ground	

15)	EXT/INT STD. FREQUENCY INPUT (Slide Switch):	Selects internal/external frequency standard (see Item 14 above).
16)	10 MHz OUTPUT (Connector, BNC):	Provides frequency standard output.
17)	FREQUENCY ADJUST (Coarse, Fine):	Internal time base frequency adjustment.
18)	STORAGE ON/OFF (Slide Switch):	Holds previous display while new count is being made. May be disabled by turning switch to OFF position.
19)	REMOTE (Cover Plate):	Optional equipment.
20)	"A" INPUT, "B" INPUT, "C" INPUT, "D" INPUT (Cover Plates):	Optional equipment.

3.3 BCD OUTPUTS

BCD outputs of measurement readings in the front panel display window are simultaneously available at the rear panel BCD OUT connector. These outputs are listed in Table 3.1.

3.4 COUNTER INPUT IMPEDANCE

As illustrated in Figure 3.11 the counter input impedance decreases at higher frequencies. This decrease is due to capacitive loading effects of the input amplifier and stray capacities of the input circuit. If a signal source of fixed impedance is connected to the counter input, a meter at the signal source will not indicate the true input level at the counter input. To avoid this error, the level at the counter input should be monitored with a high impedance voltmeter to ensure a satisfactory input level.

3.5 INITIAL TURN-ON AND CHECKOUT PROCEDURES

The following procedures may be used to verify operation of the instrument after initial installation, or after long periods of shutdown. When installing the instrument for the first time, check the rear panel MAIN PWR. switch to be certain the proper line voltage is indicated (115 VAC/230 VAC). Install the instrument power cord in the proper outlet; then allow the crystal oven at least one hour to stabilize before making functional measurements. (Oscillator stability is optimized by leaving the instrument power cord connected to the power outlet at all times.) Calibrate the oscillator against a secondary frequency standard after the instrument is stabilized, and at regular intervals thereafter.

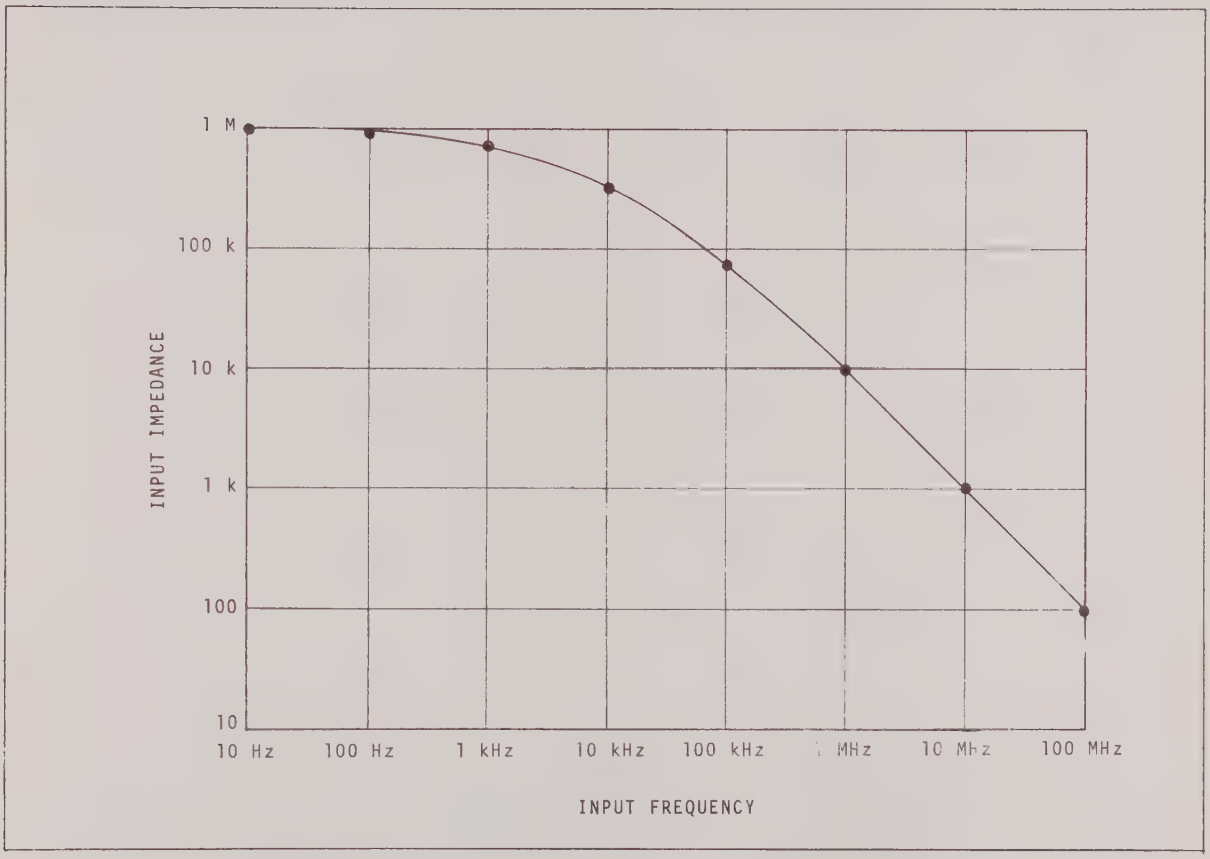


FIGURE 3.11 INPUT IMPEDANCE vs INPUT FREQUENCY

3.5.1 Functional Checkout-Rate A/Rate D (Figure 3.12)

1) Turn instrument POWER switch to the ON position.

2) Press TEST pushbutton.

3) Set RECYCLE RATE (FAST/SLOW) switch to the SLOW position. Adjust RECYCLE RATE potentiometer for ease of reading.

4) Turn the FUNCTION switch to the RATE A or RATE D position.

5) Press the RESOLUTION pushbuttons (1 MHz to 0.1 Hz consecutively), and note the test readings. Compare these readings with the data shown in Table 3.2.

3.5.2 Functional Checkout-Period/Mult. Period (Figure 3.12)

1) Turn instrument POWER switch to the ON position.

2) Press TEST pushbutton.

3) Set RECYCLE RATE (FAST/SLOW) switch to the SLOW position. Adjust RECYCLE RATE potentiometer for ease of reading.

4) Turn the FUNCTION switch to the PERIOD positions (PERIOD x 1 to PERIOD x 10^5 consecutively), and compare the test readings with the data shown in Table 3.3.

3.5.3 Functional Checkout-Ratio/Mult. Ratio (Figure 3.12)

1) Turn instrument POWER switch to the ON position.

2) Press TEST and RATIO A/B pushbutton.

3) Set RECYCLE RATE (FAST/SLOW) switch to the SLOW position. Adjust RECYCLE RATE potentiometer for ease of reading.

4) Turn the FUNCTION switch to the RATIO positions (RATIO 1 to RATIO x 10^5 consecutively), and compare the test readings with the data shown in Table 3.4.

3.6 DC TO 200 MHz FREQUENCY MEASUREMENT-RATE A (Figure 3.13)

1) Turn instrument POWER switch to the ON position.

2) Set RECYCLE RATE (FAST/SLOW) switch to the SLOW position. Adjust RECYCLE RATE potentiometer for ease of reading.

3) Turn the FUNCTION switch to the RATE A position.

4) Press desired RESOLUTION pushbutton (1 MHz to 0.1 Hz). Check to be certain that TEST pushbutton is deactivated.

5) Turn the "A" INPUT LEVEL control to the PRESET position.

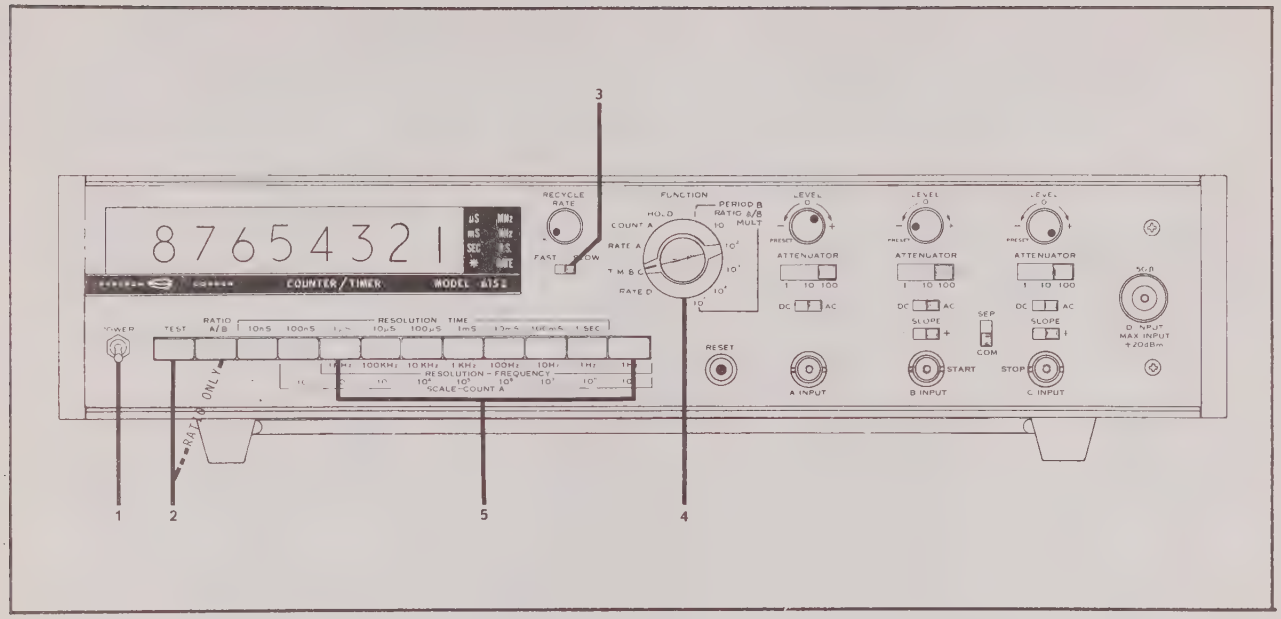


FIGURE 3.12 INITIAL TEST PROCEDURES.

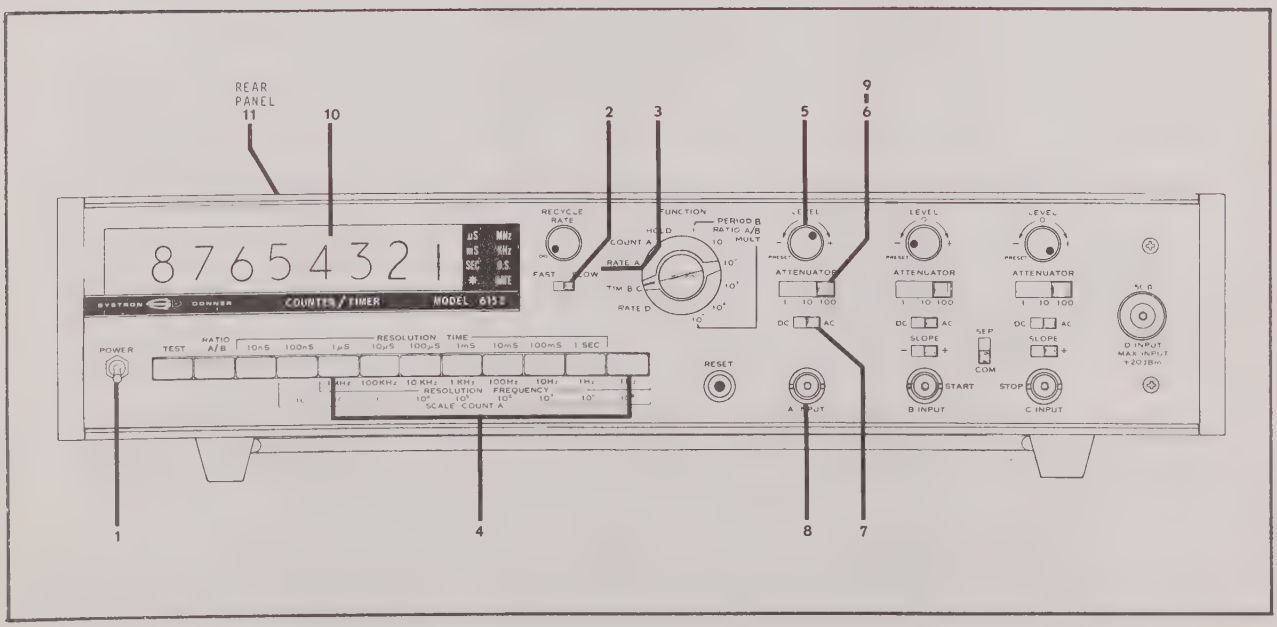


FIGURE 3.13 FREQUENCY MEASUREMENT - RATE A.

Table 3.2 TEST-RATE A/RATE D-Numerical Display (±1 Count) and Measurement Units

RESOLUTION (Pushbutton)	Decimal Location		Measurement
	RATE A	RATE D	
1 MHz	00000100(.)	00002560(.)	MHz
100 kHz	0000100.0	0002560.0	MHz
10 kHz	000100.00	002560.00	MHz
1 kHz	00100000(.)	02560000(.)	kHz
100 Hz	0100000.0	2560000.0	kHz
10 Hz	100000.00	560000.00	kHz
1 Hz	*(1)00000.000	*60000.000	kHz
0.1 Hz	*(1)(0)0000.0000	*0000.0000	kHz

* Most Significant Digit(s) off Scale

(If the 10 ns or 100 ns pushbuttons are pressed, an asterisk will appear in the Annunciator Display indicating an unallowable switch condition.)

Table 3.3 TEST-PERIOD/MULT. PERIOD-Numerical Display (±1 Count) and Measurement Units

Period x 1	Period x 10	Period x 10^2	Period x 10^3	Period x 10^4	Period x 10^5
000000.10 µs	00000.100 µs	0000.1000 µs	000.10000 µs	00.100000 µs	0.1000000 µs

Readings are independent of RESOLUTION pushbutton settings when in TEST mode.

NOTE

The above readings apply only when 10 ns resolution option is provided; otherwise, all readings are reduced by one decade.

Table 3.4 TEST-RATIO/MULT. RATIO-Numerical Display (±1 Count).

FUNCTION (Switch)	Decimal Location
RATIO x1	00000010(.)
RATIO x10	0000010.0
RATIO x10^2	000010.00
RATIO x10^3	00010.000
RATIO x10^4	0010.0000
RATIO x10^5	010.00000

6) Set the "A" INPUT ATTENUATOR 1, 10, 100 switch to the 100 position.

7) Set "A" INPUT DC-AC switch to the AC position.

8) Connect DC to 200 MHz signal into the "A" INPUT.

9) Decrease "A" INPUT ATTENUATOR switch to a setting which ensures stable counting.

10) Read frequency directly from display. Compare with data contained in Table 3.5.

11) Set STORAGE ON/OFF switch (Rear Panel) for desired readout mode.

3.7 200 MHz to 3 GHz-FREQUENCY MEASUREMENT-RATE D (Figure 3.14)

1) Turn instrument POWER switch to the ON position.

2) Set RECYCLE RATE (FAST/SLOW) switch to the SLOW position. Adjust RECYCLE RATE potentiometer for ease of reading.

3) Turn the FUNCTION switch to the RATE D position.

4) Press desired RESOLUTION pushbutton (1 MHz to 0.1 Hz). Check to be certain that TEST pushbutton is deactivated.

5) Connect 200 MHz to 3 GHz signal into the "D" INPUT.

6) Read frequency directly from display. Compare with data contained in Table 3.5.

7) Set STORAGE ON/OFF switch (Rear Panel) for desired readout mode.

3.8 DC TO 10 MHz-PERIOD/MULT. PERIOD MEASUREMENT (Figure 3.15)

1) Turn instrument POWER switch to the ON position.

2) Set RECYCLE RATE (FAST/SLOW) switch to the SLOW position. Adjust RECYCLE RATE potentiometer for ease of reading.

3) Turn the FUNCTION switch to the desired position (PERIOD x 1 to PERIOD x 10^5).

4) Press desired RESOLUTION pushbutton (10 ns to 1 sec.). Check to be certain that TEST pushbutton is deactivated.

5) Set SEParate/COMmon switch to the SEParate position.

6) Turn the "B" INPUT LEVEL control to the PRESET position.

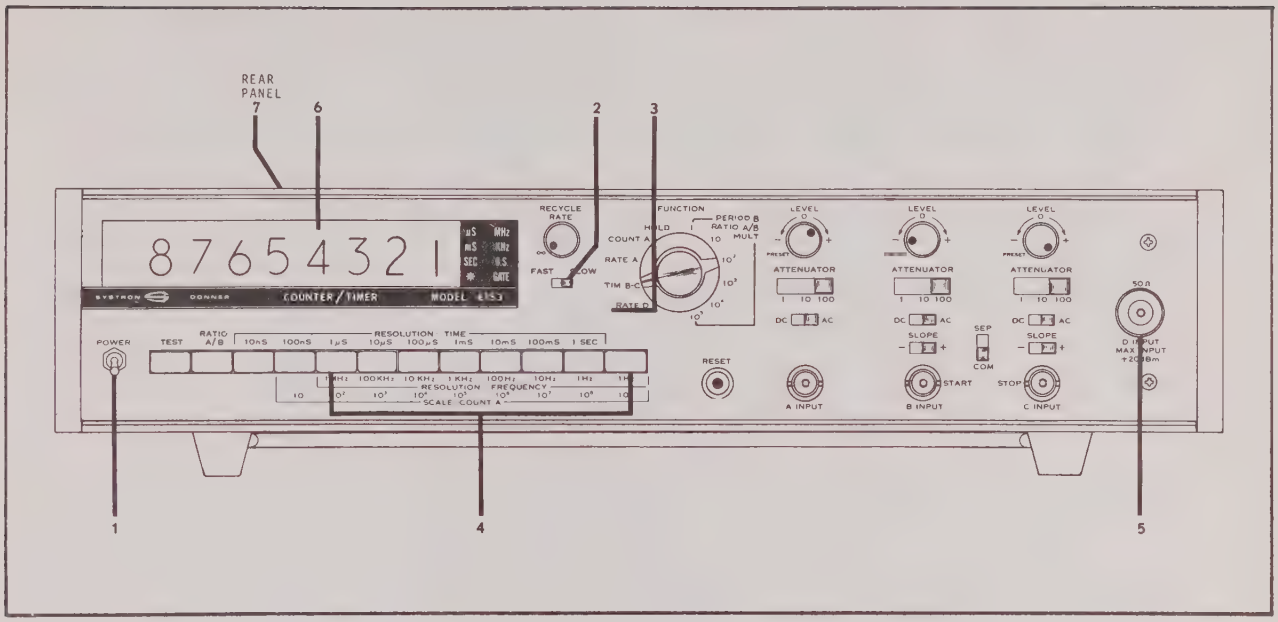


FIGURE 3.14 FREQUENCY MEASUREMENT - RATE D.

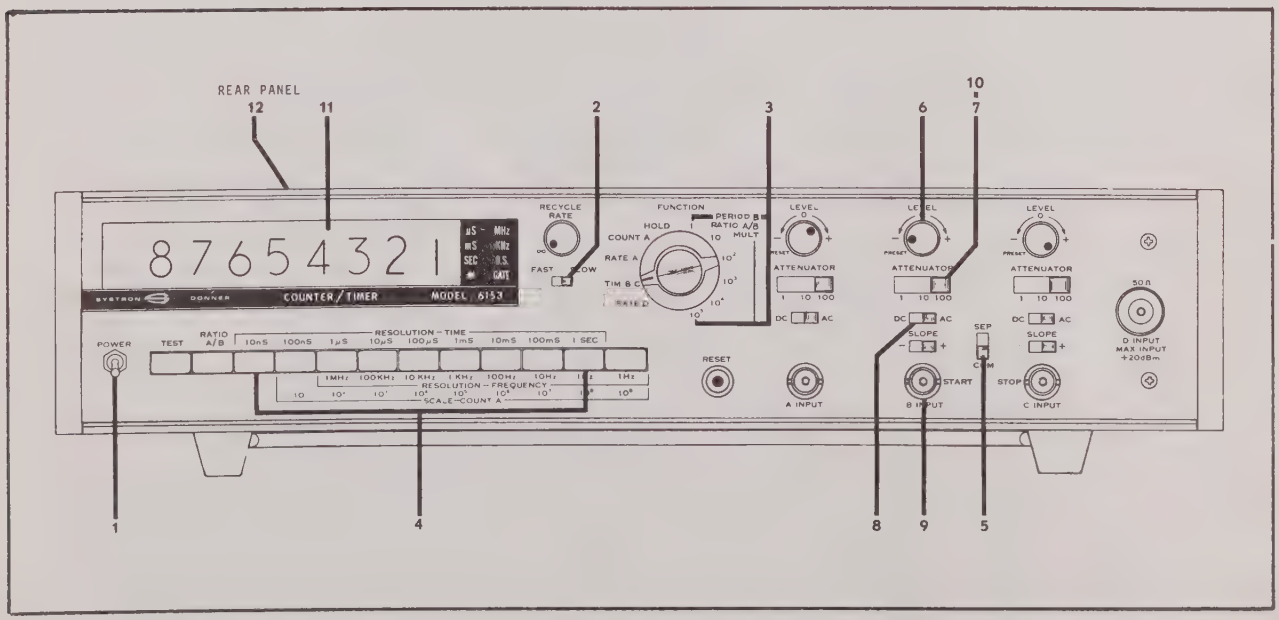


FIGURE 3.15 PERIOD/MULTIPLE PERIOD MEASUREMENT.

Table 3.5 RATE A/RATE D-Decimal Location and Measurement Units.

Digit Position	*MSD (8)	(7)	(6)	(5)	(4)	(3)	(2)	**LSD (1)
Decimal Position	(7)	(6)	(5)	(4)	(3)	(2)	(1)	(0) No Light
RESOLUTION (Pushbutton)	1 MHz	100 kHz	10 kHz	1 kHz	100 Hz	10 Hz	1 Hz	0.1 Hz
D.L. / M.U.	0 / MHz	1 / MHz	2 / MHz	0 / kHz	1 / kHz	2 / kHz	3 / kHz	4 / kHz

* Most Significant Digit

** Least Significant Digit

TYPICAL

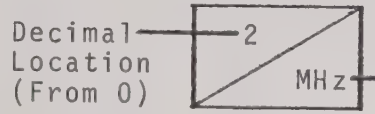


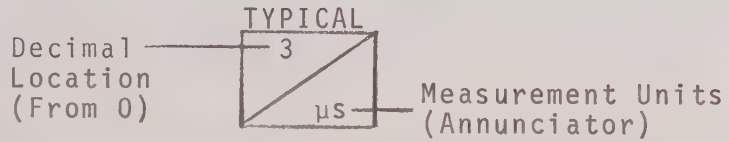
Table 3.6 PERIOD/MULT. PERIOD-Decimal Location and Measurement Units.

Digit Position	*MSD (8)	(7)	(6)	(5)	(4)	(3)	(2)	**LSD (1)
Decimal Position	(7)	(6)	(5)	(4)	(3)	(2)	(1)	(0) No Light

RESOLUTION (Pushbuttons)

	10ns	100ns	1µs	10µs	100µs	1ms	10ms	100ms	1s
PERIOD x1	2 µs	1 µs	0 µs	2 ms	1 ms	0 ms	2 s	1 s	0 s
PERIOD x10	3 µs	2 µs	1 µs	0 µs	2 ms	1 ms	0 ms	2 s	1 s
PERIOD $x10^2$	4 µs	3 µs	2 µs	1 µs	0 µs	2 ms	1 ms	0 ms	2 s
PERIOD $x10^3$	5 µs	4 µs	3 µs	2 µs	1 µs	0 µs	2 ms	1 ms	3 s
Period $x10^4$	6 µs	5 µs	4 µs	3 µs	2 µs	1 µs	3 ms	2 ms	4 s
Period $x10^5$	7 µs	6 µs	5 µs	4 µs	3 µs	2 µs	4 ms	3 ms	5 s

* Most Signigicant Digit
** Least Significant Digit



7) Set the "B" INPUT ATTENUATOR 1, 10, 100 switch to the 100 position.

8) Set "B" INPUT DC-AC switch to the AC position.

9) Connect DC to 10 MHz signal into the "B" INPUT.

10) Decrease "B" INPUT ATTENUATOR switch to a setting which ensures stable counting.

11) Read period directly from display. Compare with data contained in Table 3.6.

12) Set STORAGE ON/OFF switch (Rear Panel) for desired read-out mode.

3.9 DC TO 200 MHz-RATIO/MULT. RATIO MEASUREMENT (Figure 3.16)

1) Turn instrument POWER switch to the ON position.

2) Set RECYCLE RATE (FAST/SLOW) to the SLOW position. Adjust RECYCLE RATE potentiometer for ease of reading.

3) Turn the FUNCTION switch to the desired position (RATIO A/B x 1 to x 10^5).

4) Press the RATIO A/B pushbutton. Check to be certain that TEST pushbutton is deactivated.

5) Turn the "A" INPUT LEVEL control to the PRESET position.

6) Set the "A" INPUT ATTENUATOR 1, 10, 100 switch to the 100 position.

7) Set the "A" INPUT DC-AC switch to the AC position.

8) Connect DC to 200 MHz (Numerator) signal into the "A" INPUT.

9) Turn the "B" INPUT LEVEL control to the PRESET position.

10) Set the "B" INPUT ATTENUATOR 1, 10, 100 switch to the 100 position.

11) Set the "B" INPUT DC-AC switch to the AC position.

12) Connect DC to 10 MHz (Denominator) signal into the "B" INPUT.

13) Decrease "B" INPUT ATTENUATOR switch to a setting which causes the GATE lamp (Annunciator) to light consistently.

14) Decrease "A" INPUT ATTENUATOR switch to a setting which ensures stable counting.

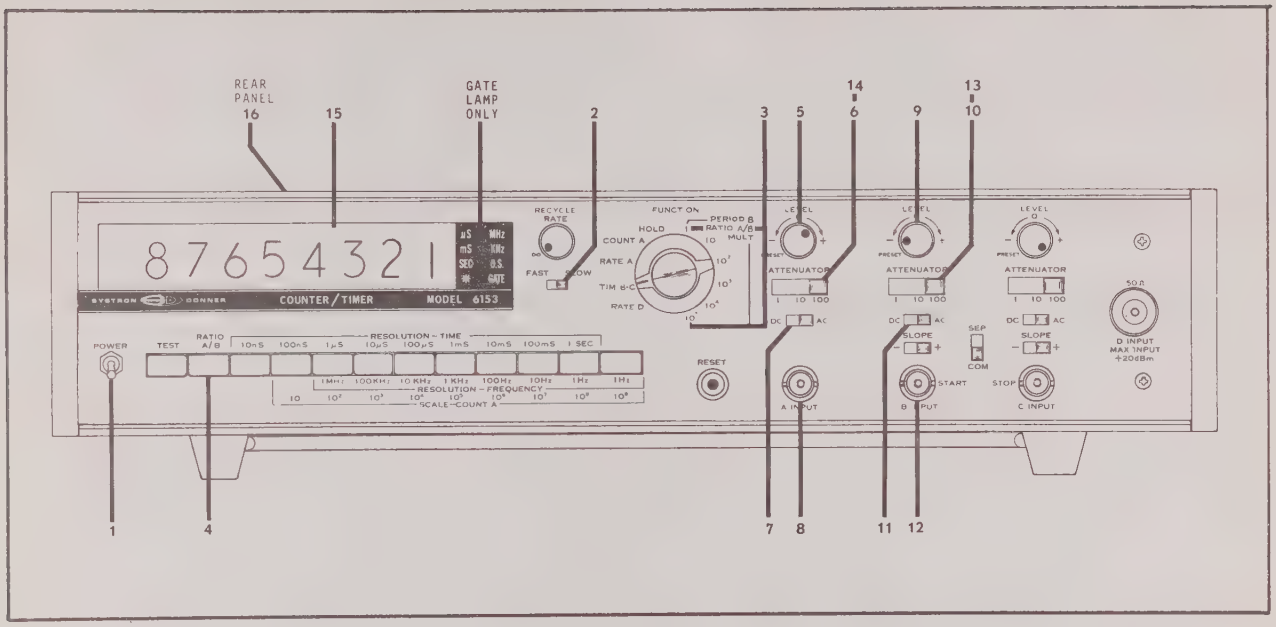


FIGURE 3.16 RATIO/MULTIPLE RATIO MEASUREMENT.

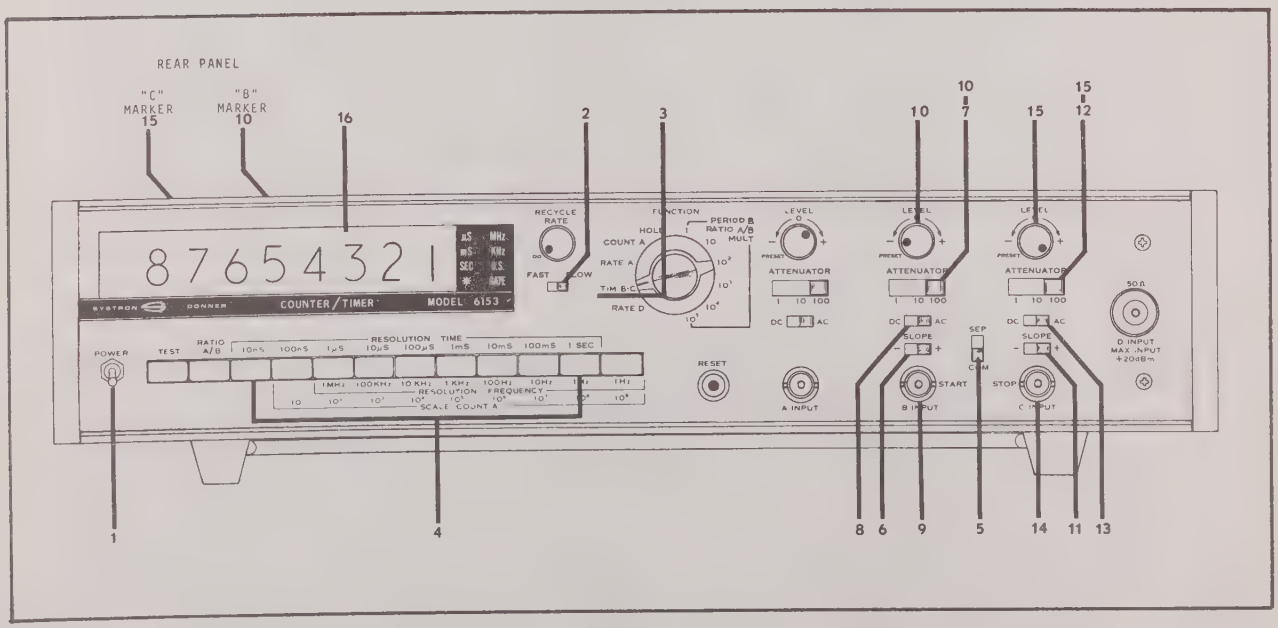


FIGURE 3.17 TIME INTERVAL MEASUREMENT.

Table 3.7 RATIO/MULTIPLE RATIO - Decimal Location

Digit Position	*MSD (8)	(7)	(6)	(5)	(4)	(3)	(2)	**LSD (1)	
Decimal Position	(7)	(6)	(5)	(4)	(3)	(2)	(1)	(0) No Light	
Resolution (Pushbutton) RATIO A/B			$X10^5$	$X10^4$	$X10^3$	$X10^2$	X10	X1	
D.L. / M.U.			5 / (none)	4 / (none)	3 / (none)	2 / (none)	1 / (none)	0 / (none)	

TYPICAL

Decimal Location (From 0) — 1 / (none) — Measurement Units (Annunciator)

*Most Significant Digit
**Least Significant Digit

15) Read ratio directly from display. Compare with data contained in Table 3.7.

16) Set STORAGE ON/OFF switch (Rear Panel) for desired readout mode.

3.10 100 ns to 10^8 SECONDS-TIME INTERVAL MEASUREMENT (Figure 3.17)

1) Turn instrument POWER switch to the ON position.

2) Set RECYCLE RATE (FAST/SLOW) switch to the SLOW position. Adjust RECYCLE RATE potentiometer for ease of reading.

3) Turn the FUNCTION switch to the TIM B-C position.

4) Press desired RESOLUTION pushbutton (10 ns to 1 sec). Check to be certain that TEST pushbutton is deactivated.

5) Set SEParate/COMmon switch as follows:

   a) When measuring the time interval between two points on the same waveform, set the SEParate/COMmon switch to the COMmon position and use the "B" INPUT only.

   b) When the time interval between two points on separate waveforms, or between two pulses from separate sources is measured, set to the SEParate position; then, use the "B" INPUT for Start signals and the "C" INPUT for Stop signals.

6) Set "B" INPUT SLOPE switch to (+) or (-) depending on polarity of input signals.

7) Set "B" INPUT ATTENUATOR 1, 10, 100 switch to the 100 position.

8) Set "B" INPUT DC-AC switch for the proper coupling.

9) Connect the input Start or Start/Stop signals to the "B" INPUT connector.

10) Adjust the "B" INPUT LEVEL and ATTENUATOR controls to produce consistent triggering. Utilize the rear panel "B" MARKER output signal for oscilloscope sychronization.

11) Set "C" INPUT SLOPE switch to (+) or (-) depending on polarity of input signals.

12) Set "C" INPUT ATTENUATOR 1, 10, 100 switch to the 100 position.

13) Set "C" INPUT DC-AC switch for the proper coupling.

14) Connect the input Stop signals to the "C" INPUT connector.

Table 3.8 TIME INTERVAL-Decimal Location and Measurement Units.

Digit Position	(8)	(7)	(6)	(5)	(4)	(3)	(2)	(1)	
Decimal Position		(7)	(6)	(5)	(4)	(3)	(2)	(1)	(0) No Light
RESOLUTION (Pushbutton)	10ns	100ns	1µs	10µs	100µs	1ms	10ms	100ms	1s
D.L. / M.U.	2 / µs	1 / µs	0 / µs	2 / ms	1 / ms	0 / ms	2 / s	1 / s	0 / s

* Most Significant Digit

** Least Significant Digit

TYPICAL

Decimal Location (From 0) — 2 / µs — Measurement Units (Annunciator)

15) Adjust the "C" INPUT LEVEL and ATTENUATOR controls to produce consistent triggering. Utilize the rear panel "C" MARKER output signal for oscilloscope synchronization.

16) Read time interval data directly from display. Compare with information contained in Table 3.8.

3.11 TOTALIZE/SCALE MEASUREMENT (Figure 3.18)

1) Turn instrument POWER switch to the ON position.

2) Turn the FUNCTION switch to the COUNT A position. Check to be certain that TEST pushbutton is deactivated.

3) Turn the "A" INPUT LEVEL control to the PRESET position.

4) Set the "A" INPUT ATTENUATOR 1, 10, 100 switch to the 100 position.

5) Set the "A" INPUT DC-AC switch to the AC position.

6) Connect count signals into the "A" INPUT.

7) Decrease "A" INPUT ATTENUATOR switch to a setting which ensures stable counting.

8) Turn the FUNCTION switch to the HOLD position.

9) Press the RESET pushbutton to clear the counter display.

10) When ready to totalize, turn the FUNCTION switch to the COUNT A position; the totalize routine will commence.

11) When ready to stop, turn the FUNCTION switch to the HOLD position; the totalize routine will cease.

12) Read the totalized count directly from the display.

13) To scale an "A" INPUT frequency, press desired RESOLUTION pushbutton (SCALE-COUNT A, 10 to 10^9); and, couple the scaled frequency from the Time Base SCALE OUTput BNC connector. Scale factor for the frequency division is determined by the RESOLUTION pushbutton selected.

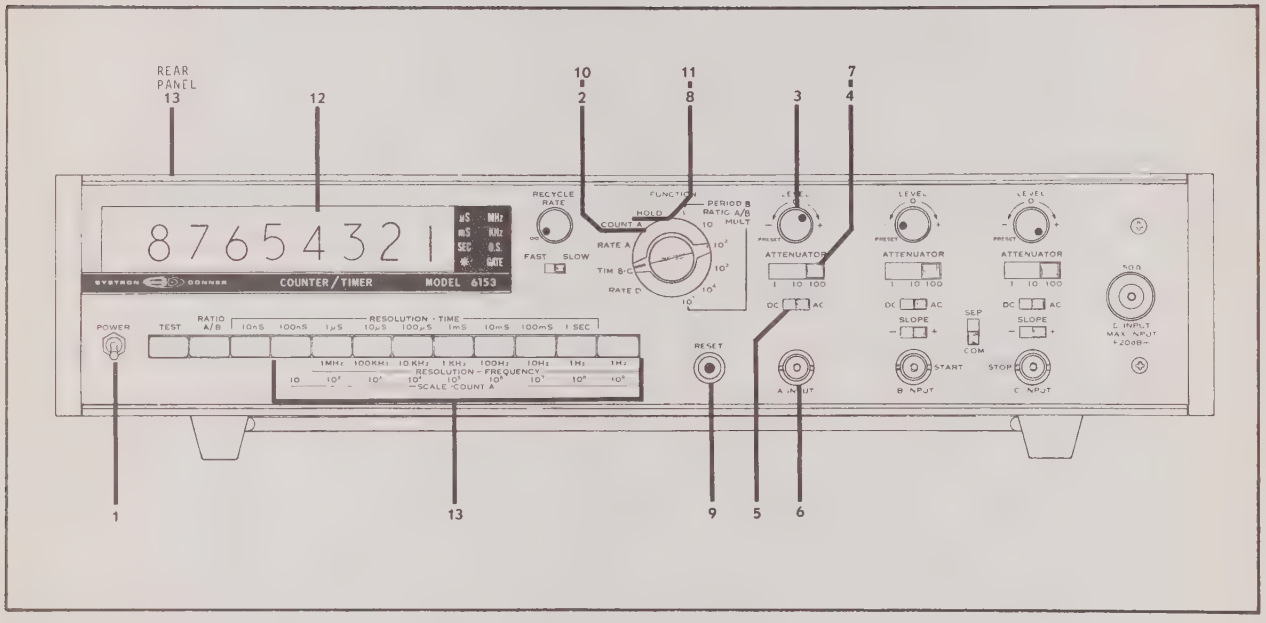


FIGURE 3.18 TOTALIZE/SCALE MEASUREMENT.

CHAPTER 4
PRINCIPLES OF OPERATION

4.1 INTRODUCTION

The Model 6153-50 is an integrated circuit, multi-function counter that measures the frequency and period of a signal; the time interval between two points on a signal, or on two related or unrelated signals; the ratio of two frequencies; or the total number of signal pulses. Measurements are classified under the two basic functions of Frequency and Period. Other operating modes are modifications of these two functions. The measuring techniques compare the frequency or period of an unknown signal to a time base derived from a reference frequency.

Figure 4.1 is a functional block diagram of the instrument. The system consists of front panel controls, input amplifier-shapers, function select logic, function control logic, time base, oscillator reference, decade counters, readout unit, and power supply. The FUNCTION switch on the front panel connects the appropriate circuit for the particular measuring function through the function select logic. The RESOLUTION switch selects a time base reference signal. The combined positions of the two switches determine the proper decimal point placement and measurement unit indication in the readout.

When an unknown signal is connected to the instrument, the input amplifier-shaper converts the signal into a rectangular waveform. In Frequency mode, the rectangular waveform is converted into counting pulses that are directed to the decade counters when the count gate is opened by the selected time base. In Period mode, the rectangular waveform opens the count gate for one period of the unknown signal. During this period the decade counters count the number of pulses from the time base.

In either mode, the serial data is converted into BCD format by the decade counters. Then the BCD data is decoded into decimal outputs by the decimal decoders. The decimal decoders drive eight decimal readout tubes that indicate the measurement, along with measurement unit indication, and decimal point placement. Display time of the measurement, independent of gate time, is manually adjustable from 500 microseconds to 5 seconds depending on the position of the FAST/SLOW switch and the RECYCLE RATE potentiometer. The readout unit continuously displays the most recent measurement at the end of each gate time.

4.2 LOGIC DEVICES

Table 4.1 indicates the typical integrated circuit devices found in this instrument.

4.3 LOGIC SYMBOLS

The symbols used in this manual are standardized by MIL-STD-806B, dated February 26, 1962. Symbols used for a gate depend on whether

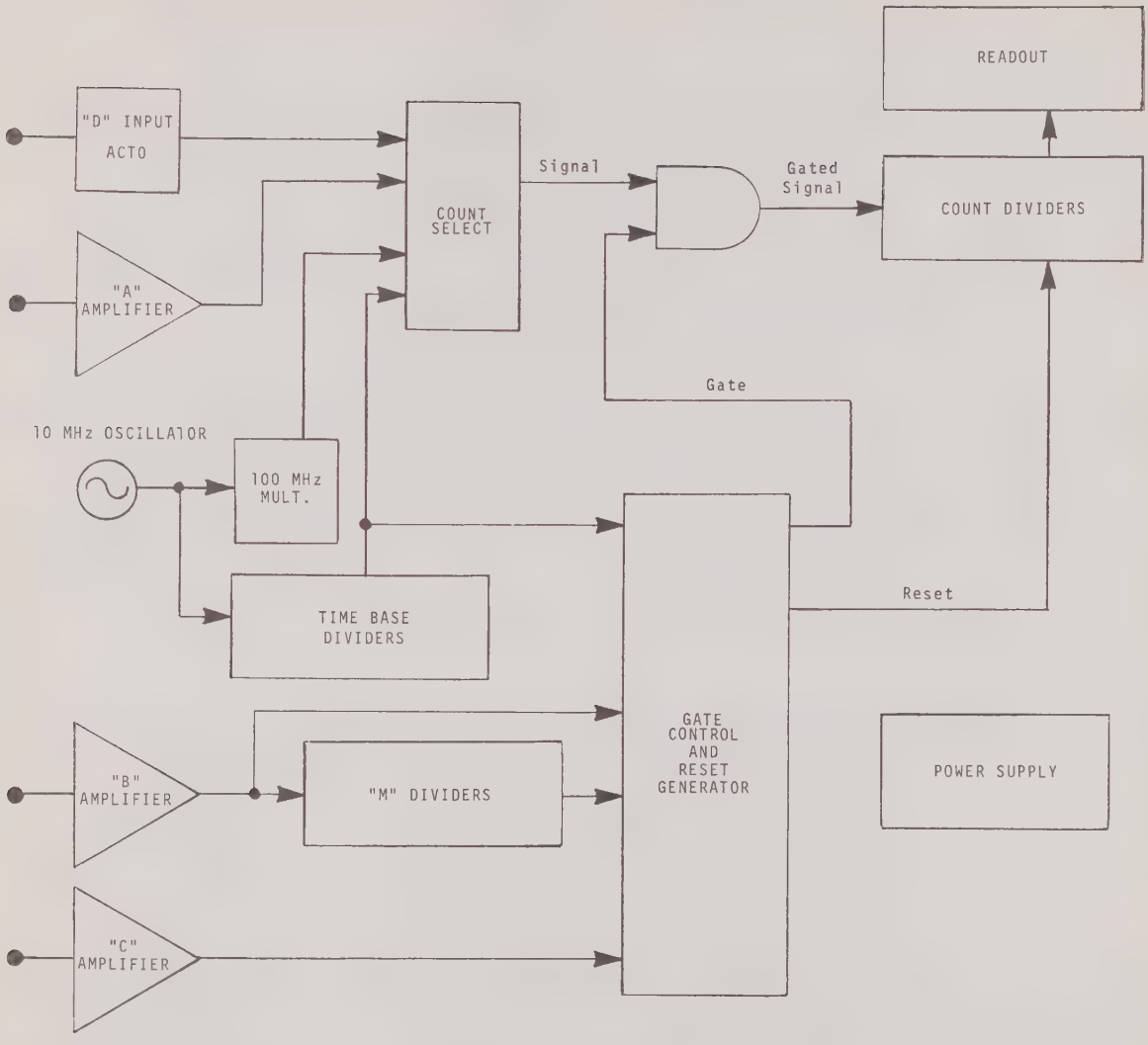


FIGURE 4.1 FUNCTIONAL BLOCK DIAGRAM.

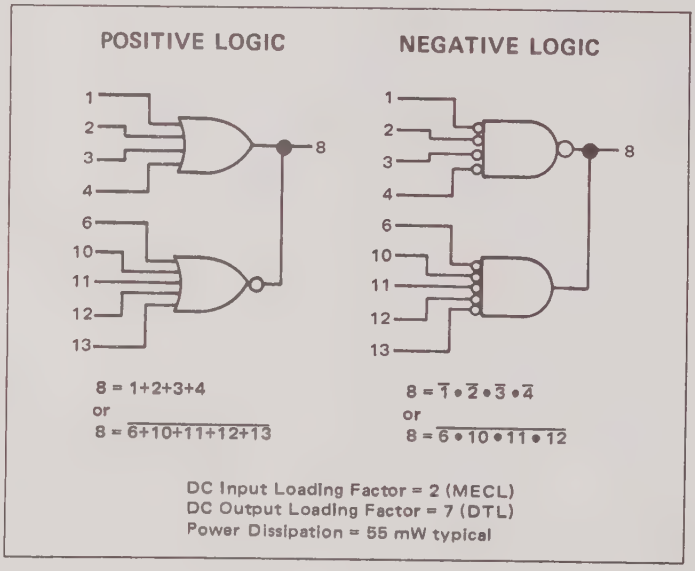
TABLE 4.1 TYPICAL I.C. COMPONENTS IN MODEL 6153-50

SD PART	DESCRIPTION	T.I.	MOTOROLA	NATIONAL	RCA	SIGNETICS
19712	Dual 4 Input Gate	SN15830N	MC830P			
25741	Hex Inverter	SN15836N	MC836P			
19716	Quad 2 Input Gate	SN1584bN	MC846P			
19719	Triple 3 Input Gate	SN15862N	MC862P			
25734	Quad 2 Input Gate		MC1808P			
25753	Quad 2 Input Buffer		MC857P			
19705	Quad 2 Input Gate	SN7400N	MC7400P	DM8000		
19706	Triple 3 Input Gate	SN7410N	MC7410P	DM8010		
19709	Dual JK F.F.	SN7473N	MC7473P	DM8073		
25241	Dual D F.F.	SN7474N	MC7474P	DM8074		
19710	Quad Latch	SN7475N	MC7475P	DM8075		
25731	Quad Latch	SN7075N				
19711	Decade Counter	SN7490N	MC7490P	DM8090		
25732	Decade Counter	SN7090N				
19707	BCD-Dec. Decoder	SN7441AN	MC7441P			N7441B
25730	BCD-Dec. Decoder	SN7041AN				
25727	Binary Counter					N8281A
25722	Decade Counter					N8280A
25718	Dual 4-1 Clock Drive		MC1023P			
25719	JK F.F.		MC1027P			
25745	Oper. Amp.			LM201		
25729	Oper. Amp.		MC1439P			
25725	Trans. Array				CA3046	
25724	Six Trans. Array				CA3026	
25702	R.F. Amp.				CA3028A	
25720	R.F. Amp.				CA3018	

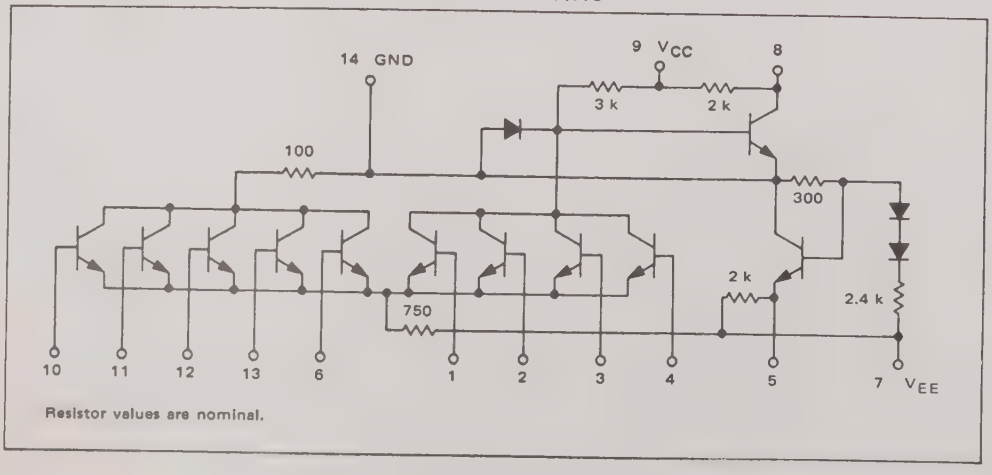
MECL-TO-SATURATED LOGIC
TRANSLATORS

MC1018
MC1218

Level translator intended for converting MECL signal levels to saturated logic levels. The translator will provide the positive logic OR or logic NOR function by connecting the internal bias driver output to the corresponding inputs of the differential amplifier. i.e., when pin 4 is connected to the reference bias, pin 5, pins 6, 10, 11 12, and 13 become the inputs of a 5-input NOR gate. When pin 6 is connected to the reference bias, pin 5, pins 1, 2, 3, and 4 become the inputs of a 4-input OR gate.



CIRCUIT SCHEMATIC



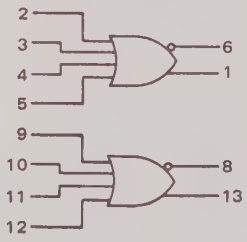
DUAL 4-INPUT
CLOCK DRIVER

MC1023

Provides simultaneous OR/NOR or AND/NAND output functions. It contains an internal bias reference insuring that the threshold point is always in the center of the transition region over the temperature range.

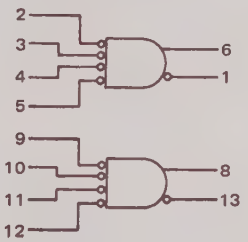
This circuit is designed to operate in high-speed digital computer applications as a clock driver or as a high-speed gate.

POSITIVE LOGIC



$6 = \overline{2+2+4+5}$
$1 = 2+3+4+5$

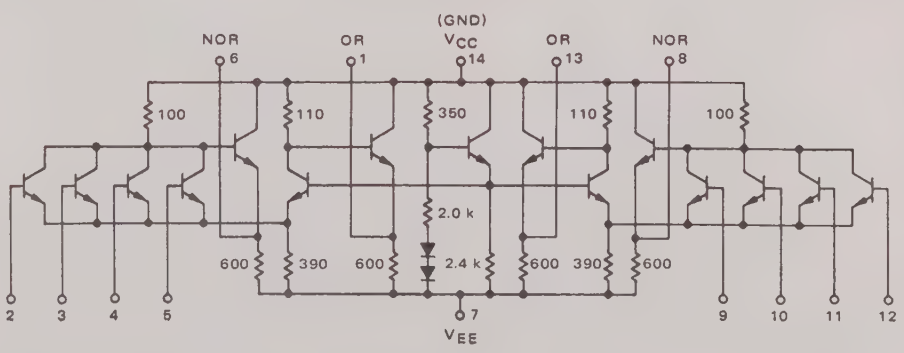
NEGATIVE LOGIC



$6 = \overline{2 \bullet 3 \bullet 4 \bullet 5}$
$1 = 2 \bullet 3 \bullet 4 \bullet 5$

DC Input Loading Factor = 3
DC Output Loading Factor = 25
Power Dissipation = 250 mW typical

CIRCUIT SCHEMATIC



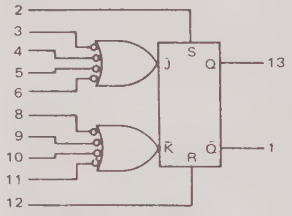
Resistor values are nominal.

120-MHz AC-COUPLED
J-K FLIP FLOPS

MC1027

Designed for use at clock frequencies to 100 MHz minimum (120 MHz typical). Logic performing inputs ($\overline{J}$ and $\overline{K}$) are available, as well as dc SET and RESET inputs.

POSITIVE LOGIC



DC Input Loading Factor = 2
DC Output Loading Factor = 25
Power Dissipation = 250 mW typical

R-S TRUTH TABLE

Pin No.	R	S	Q^{n+1}
	12	2	13
	0	0	Q^n
	0	1	1
	1	0	0
	1	1	N.D.

All $\overline{J}$-$\overline{K}$ Inputs Are Static

$\overline{J}_D$-$\overline{K}_D$ TRUTH TABLE

Pin No.	$\overline{J}_D$	$\overline{K}_D$	Q^{n+1}
	*	*	13
	0	0	Q^n
	0	1	0
	1	0	1
	1	1	$\overline{Q}^n$

All Other $\overline{J}$-$\overline{K}$ Inputs And The R-S Inputs Are At a "0" Level

CLOCKED $\overline{J}$-$\overline{K}$ TRUTH TABLE

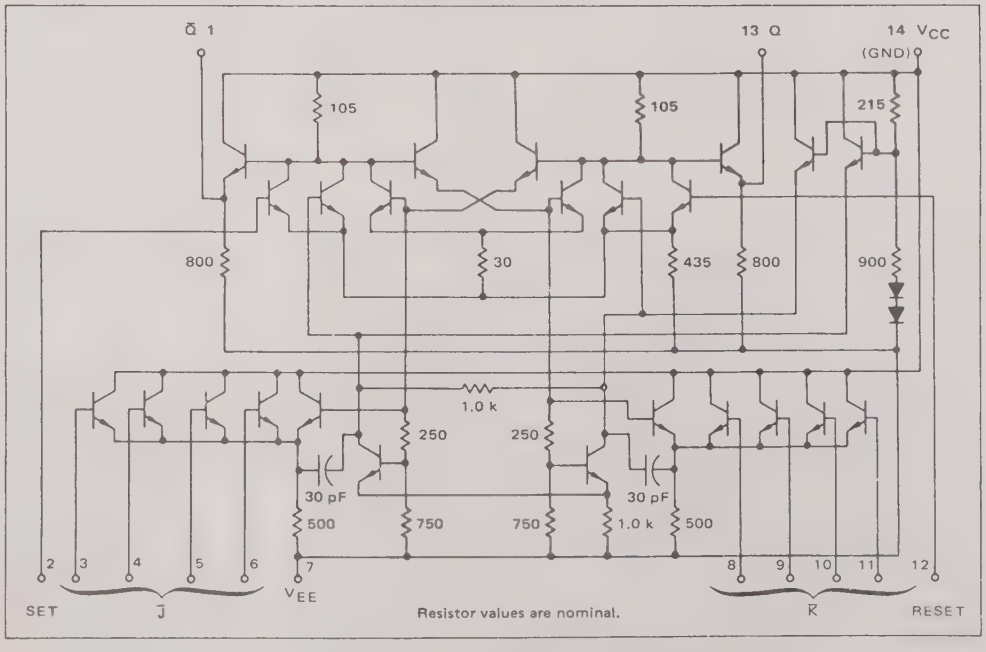
Pin No.	$\overline{J}$	$\overline{K}$	$\overline{C}_D$	Q^n
	*	*	**	13
	ϕ	ϕ	0	Q^n
	0	0	1	$\overline{Q}^n$
	0	1	1	1
	1	0	1	0
	1	1	1	Q^n

All Other $\overline{J}$-$\overline{K}$ Inputs And The R-S Inputs Are At a "0" Level

*Any $\overline{J}$ or $\overline{K}$ Input, not used for $\overline{C}_D$.
**$\overline{C}_D$ obtained by connecting one $\overline{J}$ and one $\overline{K}$ input together.

The $\overline{J}$ and $\overline{K}$ inputs refer to logic levels while the $\overline{C}_D$ input refers to dynamic logic swings. The $\overline{J}$ and $\overline{K}$ inputs should be changed to a logical "1" only while the $\overline{C}_D$ input is in a logic "1" state. ($\overline{C}_D$ maximum "1" level = V_{CC} −0.6 V). Clock $\overline{C}_D$ is obtained by tying one $\overline{J}$ and one $\overline{K}$ input together.

CIRCUIT SCHEMATIC



Resistor values are nominal.

CIRCUIT TYPE SN7441A
BCD-TO-DECIMAL DECODER/DRIVER

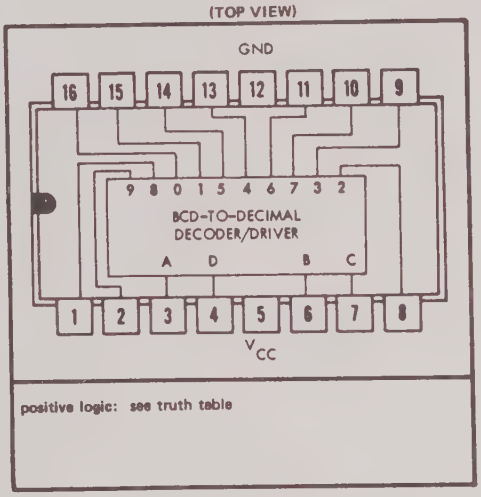
logic

TRUTH TABLE

INPUT				OUTPUT ON‡
D	C	B	A	
0	0	0	0	0
0	0	0	1	1
0	0	1	0	2
0	0	1	1	3
0	1	0	0	4
0	1	0	1	5
0	1	1	0	6
0	1	1	1	7
1	0	0	0	8
1	0	0	1	9

‡ All other outputs are off.

J OR N DUAL-IN-LINE PACKAGE
(TOP VIEW)



positive logic: see truth table

description

The SN7441A is a monolithic, BCD-to-decimal decoder incorporating high performance output transistors designed for driving gas-filled, cold-cathode indicator tubes. The BCD-to-decimal decoder consists of familiar transistor-transistor-logic (TTL) gate circuits which select one of the ten decimal output drivers. The BCD inputs are fully compatible with Series 74 logic outputs; and, in addition, physical placement of these inputs is coincidental with the BCD output of the SN7490 decade counter. The ten high-breakdown, n-p-n transistors have a maximum reverse current of 50 μA at 55 V over the operating temperature range.

A typical application shows the SN7441A used as a gas-filled, display-indicator driver.

typical application data

The SN7441A output transistors are capable of withstanding voltages and sinking current required to operate most types of gas-filled indicator tubes.

Clamping diodes have been incorporated in the outputs of this improved decoder/driver.

When these decoder/drivers are used in close proximity (on the same circuit board) with standard digital integrated circuits, care should be exercised to ensure that the impedance of the ground bus (including interconnections) is sufficiently low to absorb the normal energy levels resulting from switching the tube elements.

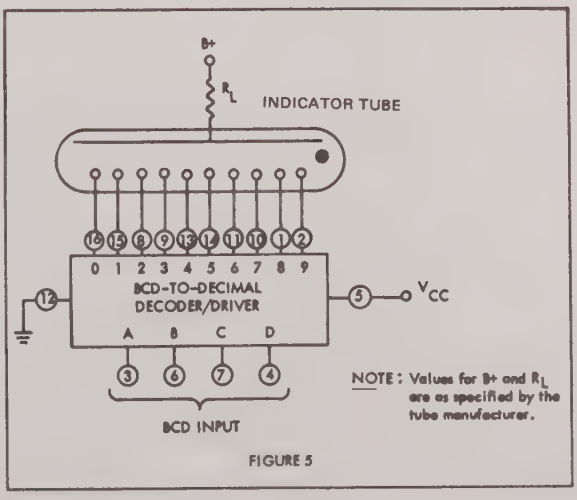


FIGURE 5

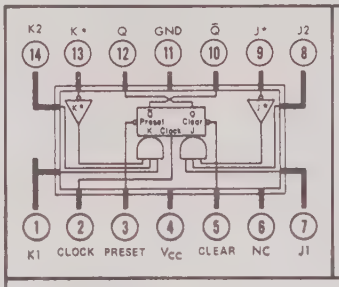
CIRCUIT TYPES SN5470, SN7470
EDGE-TRIGGERED J-K FLIP-FLOPS

logic

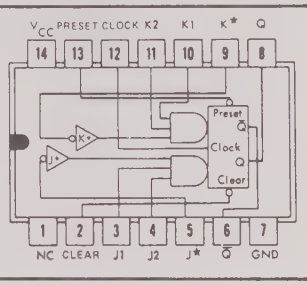
TRUTH TABLE		
t_n		t_{n+1}
J	K	Q
0	0	Q_n
0	1	0
1	0	1
1	1	$\overline{Q}_n$

NOTES:
1. $J = J1 \cdot J2 \cdot \overline{J^*}$
2. $K = K1 \cdot K2 \cdot \overline{K^*}$
3. t_n = Bit time before clock pulse.
4. t_{n+1} = Bit time after clock pulse.
5. If inputs J* or K* are not used they must be grounded.
6. NC - No Internal Connection

S FLAT PACKAGE
(TOP VIEW)



J OR N DUAL-IN-LINE PACKAGE
(TOP VIEW)



positive logic: Low input to preset sets Q to logical 1
Low input to clear sets Q to logical 0
Preset or clear function can occur only when clock input is low.

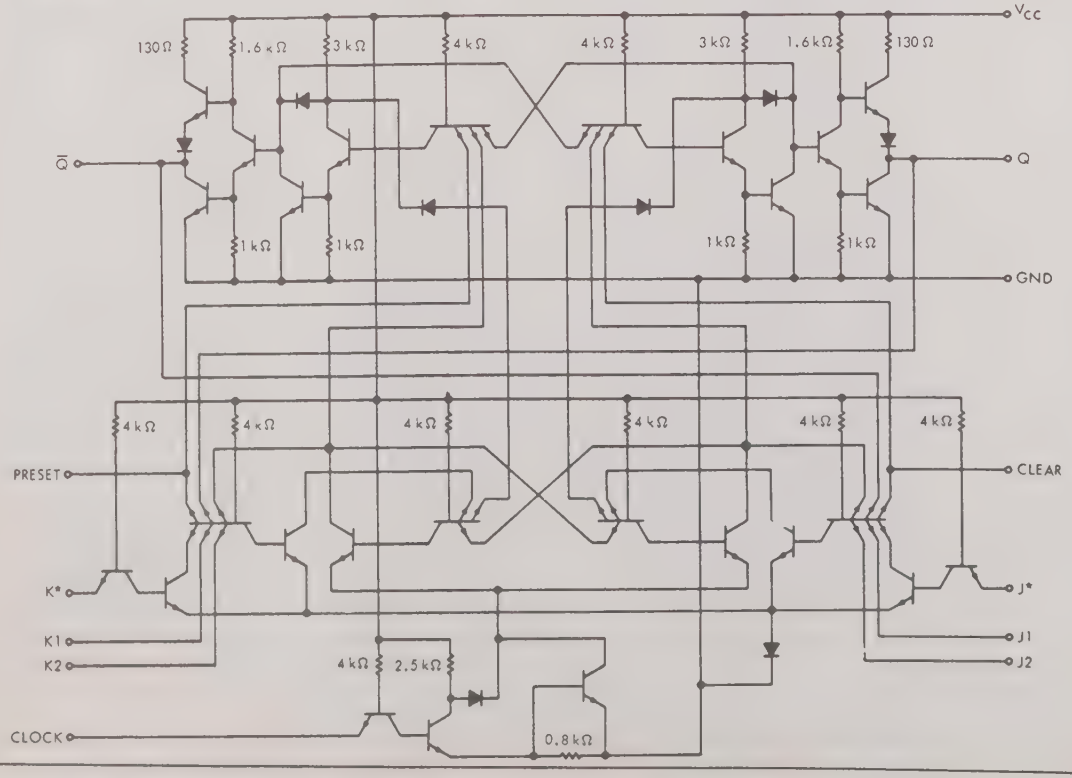
description

These monolithic, edge-triggered J-K flip-flops feature gated inputs, direct clear and preset inputs, and complementary Q and $\overline{Q}$ outputs. Input information is transferred to the outputs on the positive edge of the clock pulse.

Direct-coupled clock triggering occurs at a specific voltage level of the clock pulse, and after the clock input threshold voltage has been passed, the gated inputs are locked out.

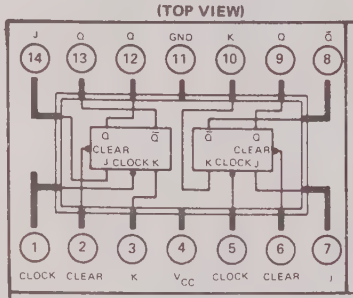
These flip-flops are ideally suited for medium- to high-speed applications and can result in a significant saving in system power dissipation and package count where input gating is required.

schematic

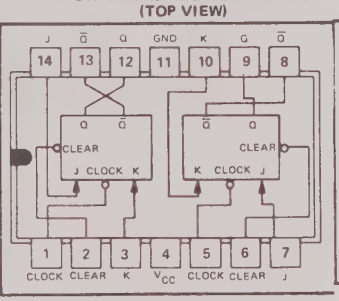


CIRCUIT TYPES SN5473
DUAL J-K MASTER-SLAVE FLIP-FLOPS

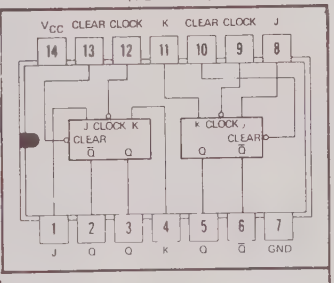
SN5473, SN7473
S FLAT PACKAGE
(TOP VIEW)



SN5473, SN7473
J OR N DUAL-IN-LINE PACKAGE
(TOP VIEW)



SN54107, SN74107
J OR N DUAL-IN-LINE PACKAGE
(TOP VIEW)



positive logic: Low input to clear sets Q to logical 0.
Clear is independent of clock.

description

These J-K flip-flops are based on the master-slave principle. Inputs to the master section are controlled by the clock pulse. The clock pulse also regulates the state of the coupling transistors which connect the master and slave sections. The sequence of operation is as follows: (See waveform on page 2-26)

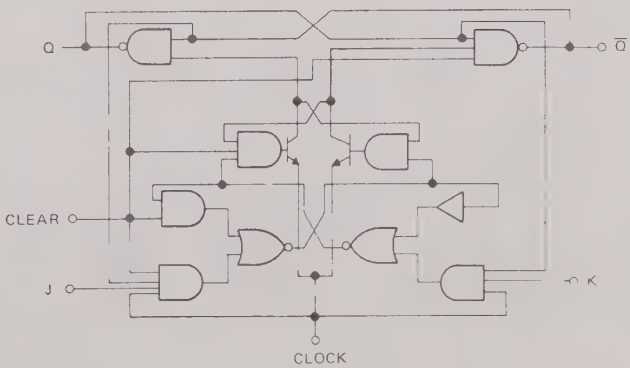
1. Isolate slave from master
2. Enter information from J and K inputs to master
3. Disable J and K inputs
4. Transfer information from master to slave.

logic

TRUTH TABLE (Each Flip-Flop)		
t_n		t_{n+1}
J	K	Q
0	0	Q_n
0	1	0
1	0	1
1	1	$\bar{Q}_n$

NOTES: 1. t_n = Bit time before clock pulse.
2. t_{n+1} = Bit time after clock pulse.

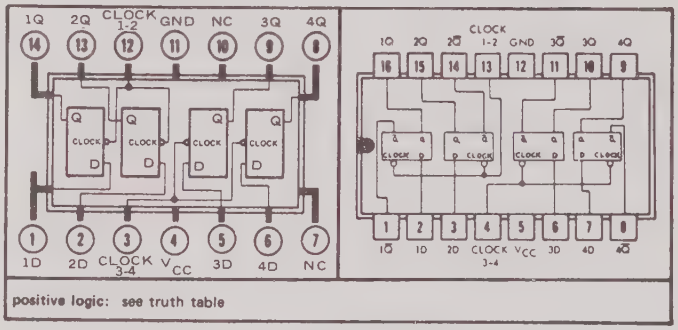
functional block diagram (each flip-flop)



CIRCUIT TYPES SN5475, 4-BIT BISTABLE LATCHES

SN5477/SN7477
S FLAT PACKAGE
(TOP VIEW)

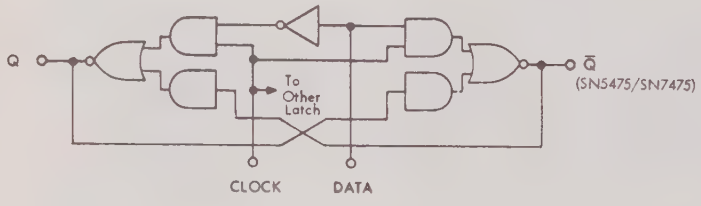
SN5475/SN7475
J OR N DUAL-IN-LINE PACKAGE
(TOP VIEW)



logic

TRUTH TABLE (Each Latch)	
t_n	t_{n+1}
D	Q
1	1
0	0

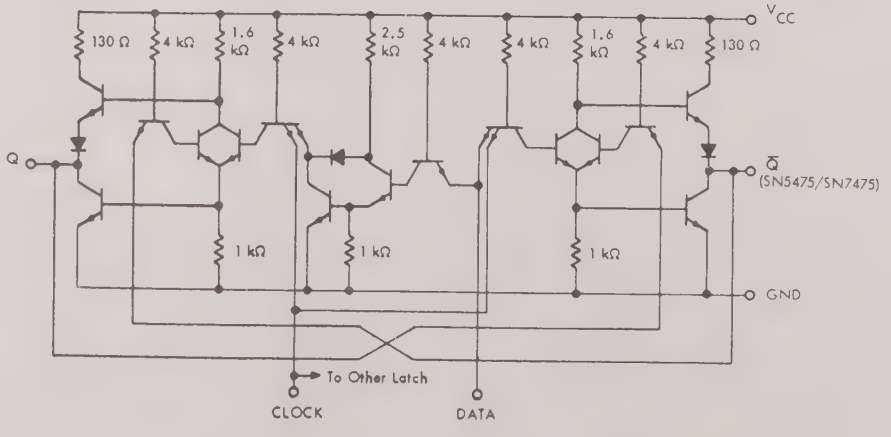
functional block diagram (each latch)



description

These latches are ideally suited for use as temporary storage for binary information between processing units and input/output or indicator units. Information present at a data (D) input is transferred to the Q output when the clock is high, and the Q output will follow the data input as long as the clock remains high. When the clock goes low, the information (that was present at the data input at the time the transition occurred) is retained at the Q output until the clock is permitted to go high.

schematic (each latch)



CIRCUIT TYPES SN5490, SN7490
DECADE COUNTERS

TRUTH TABLES

BCD COUNT SEQUENCE
(See Note 1)

COUNT	OUTPUT			
	D	C	B	A
0	0	0	0	0
1	0	0	0	1
2	0	0	1	0
3	0	0	1	1
4	0	1	0	0
5	0	1	0	1
6	0	1	1	0
7	0	1	1	1
8	1	0	0	0
9	1	0	0	1

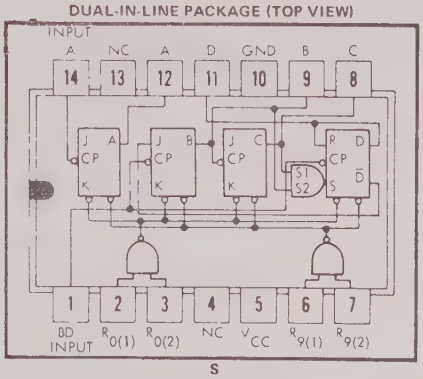
RESET COUNT (See Note 2)

RESET INPUTS				OUTPUT
$R_{0(1)}$	$R_{0(2)}$	$R_{9(1)}$	$R_{9(2)}$	D C B A
1	1	0	X	0 0 0 0
1	1	X	0	0 0 0 0
X	X	1	1	1 0 0 1
X	0	X	0	COUNT
0	X	0	X	COUNT
0	X	X	0	COUNT
X	0	0	X	COUNT

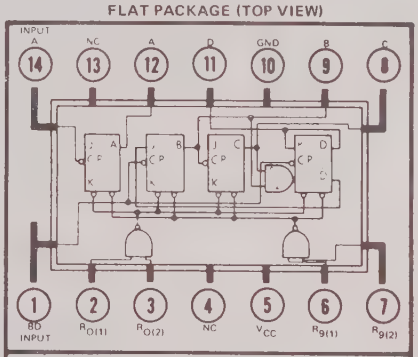
NC - No Internal Connection

NOTES: 1. Output A connected to input BD for BCD count.
2. X indicates that either a logical 1 or a logical 0 may be present.

J OR N
DUAL-IN-LINE PACKAGE (TOP VIEW)



S
FLAT PACKAGE (TOP VIEW)



positive logic: see truth table

description and typical count configurations

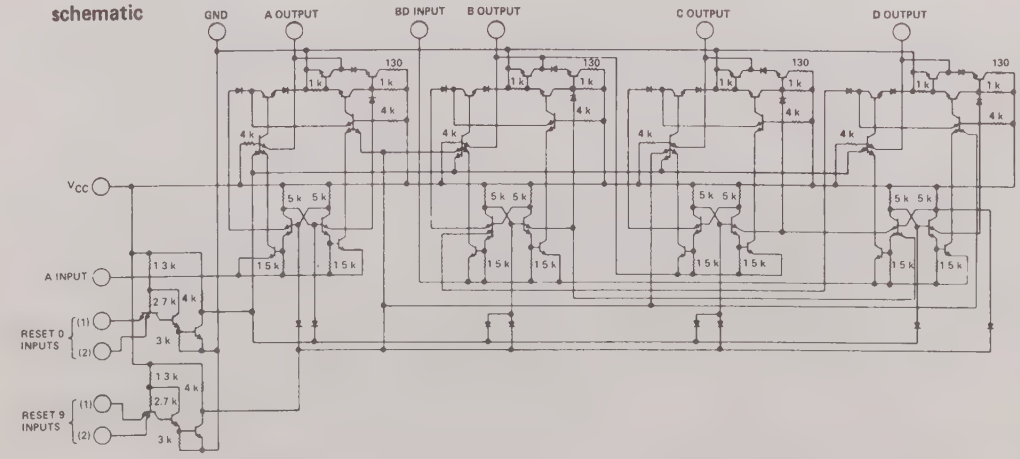
These high-speed, monolithic decade counters consist of four dual-rank, master-slave flip-flops internally interconnected to provide a divide-by-two counter and a divide-by-five counter. Gated direct reset lines are provided to inhibit count inputs and return all outputs to logical zero or to a binary coded decimal (BCD) count of 9. As the output from flip-flop A is not internally connected to the succeeding stages, the count may be separated in three independent count modes:

1. When used as a binary coded decimal decade counter, the BD input must be externally connected to the A output. The A input receives the incoming count, and a count sequence is obtained in accordance with the BCD count sequence truth table shown above. In addition to a conventional zero reset, inputs are provided to reset a BCD count for nine's complement decimal applications.

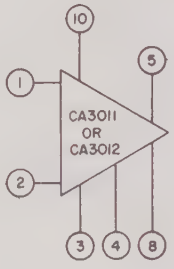
2. If a symmetrical divide-by-ten count is desired for frequency synthesizers or other applications requiring division of a binary count by a power of ten, the D output must be externally connected to the A input. The input count is then applied at the BD input and a divide-by-ten square wave is obtained at output A.

3. For operation as a divide-by-two counter and a divide-by-five counter, no external interconnections are required. Flip-flop A is used as a binary element for the divide-by-two function. The BD input is used to obtain binary divide-by-five operation at the B, C, and D outputs. In this mode, the two counters operate independently; however, all four flip-flops are reset simultaneously.

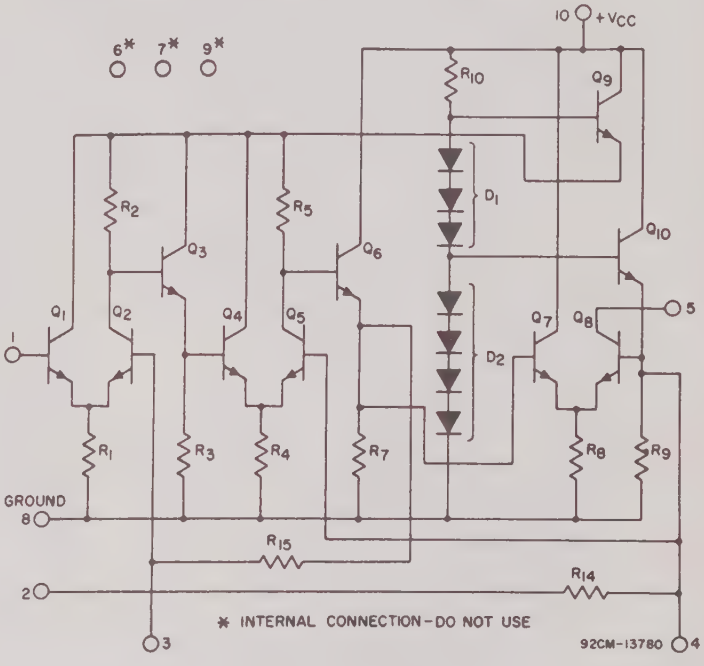
schematic



CA3011
CA3012
Wide-Band Amplifiers



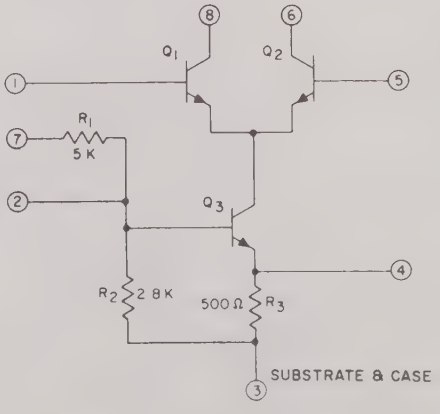
SCHEMATIC DIAGRAM FOR CA3011 AND CA3012



CA3028A
CA3028B
Differential/Cascode Amplifiers

The CA3028A and CA3028B are differential/cascode amplifiers designed for use in communications and industrial equipment operating at frequencies from dc to 120 MHz.

The CA3028B is like the CA3028A but is capable of premium performance particularly in critical dc and differential amplifier applications requiring tight controls for input offset voltage, input offset current, and input bias current.



Schematic diagram for CA3028A

the element is activated by a relatively high, or relatively low signal (see Figure 4.2). Each terminal of a device can have one of two states: "zero" or "one". Zero is the reference (inactive) state, and one is the significant (active) state. The small circle at the point where a signal line joins the symbol indicates that the line's active state is the relatively low signal. The absence of such a circle indicates that the line's active state is the relatively high signal state. For positive logic, the symbol has no circles at the input and a circle at the output. Thus, inputs are normally low when inactive, and high when activated. The output is normally high, and goes low when the gate is activated by a high signal at the input. Also, the element is performing the OR function, as indicated by the shape of the symbol, because a change of state in any one of the inputs causes a change of state in the output. For negative logic, the symbol has circles on its inputs and none on the output. All inputs must be low or in their active state before the output changes; thus, this symbol indicates the AND function.

Symbols and truth tables for logic used in this instrument are shown in Figure 4.3.

4.4 CIRCUIT DESCRIPTIONS

4.4.1 200 MHz Amplifier Board - A16 (Schematic 39320)

The printed circuit (PC) board consists of three distinct, interdependent operating circuits:

The Attenuator section is front panel switch-controlled and remotely programmed to present the Amplifier section a signal which is equal to;1/10 of; or, 1/100 of the input signal, while maintaining a constant 1 MΩ load on the input connector. The DC-AC remote selection network is also incorporated into the Attenuator section.

The Amplifier section converts the high-impedance, single-ended input to a low-impedance, differential output of sufficient amplitude to activate the emitter-coupled output logic.

The Output Shaper section imparts a uniform rise time to the signals from the amplifier section for use by the function control logic.

1) ATTENUATOR

The signal from the input connector is presented to the dc blocking capacitor C16. If dc operation is desired, DC-AC relay L4 is energized, shorting capacitor C16. If an attenuation ratio of X1 has been selected, relay L1 is energized, connecting resistor R1 and capacitor C1 to frequency compensation network L3, R4, C14 and the input BNC. Relays L2 and L3 are open, presenting the Amplifier section with, essentially, the input signal. If the input signal exceeds ±1.0 volt, diode CR4 or CR5 will conduct, protecting the Amplifier section from damage.

If an attenuation ratio of X10 is selected, relay L2 is closed and relays L1 and L3 are open. Relay L2 connects

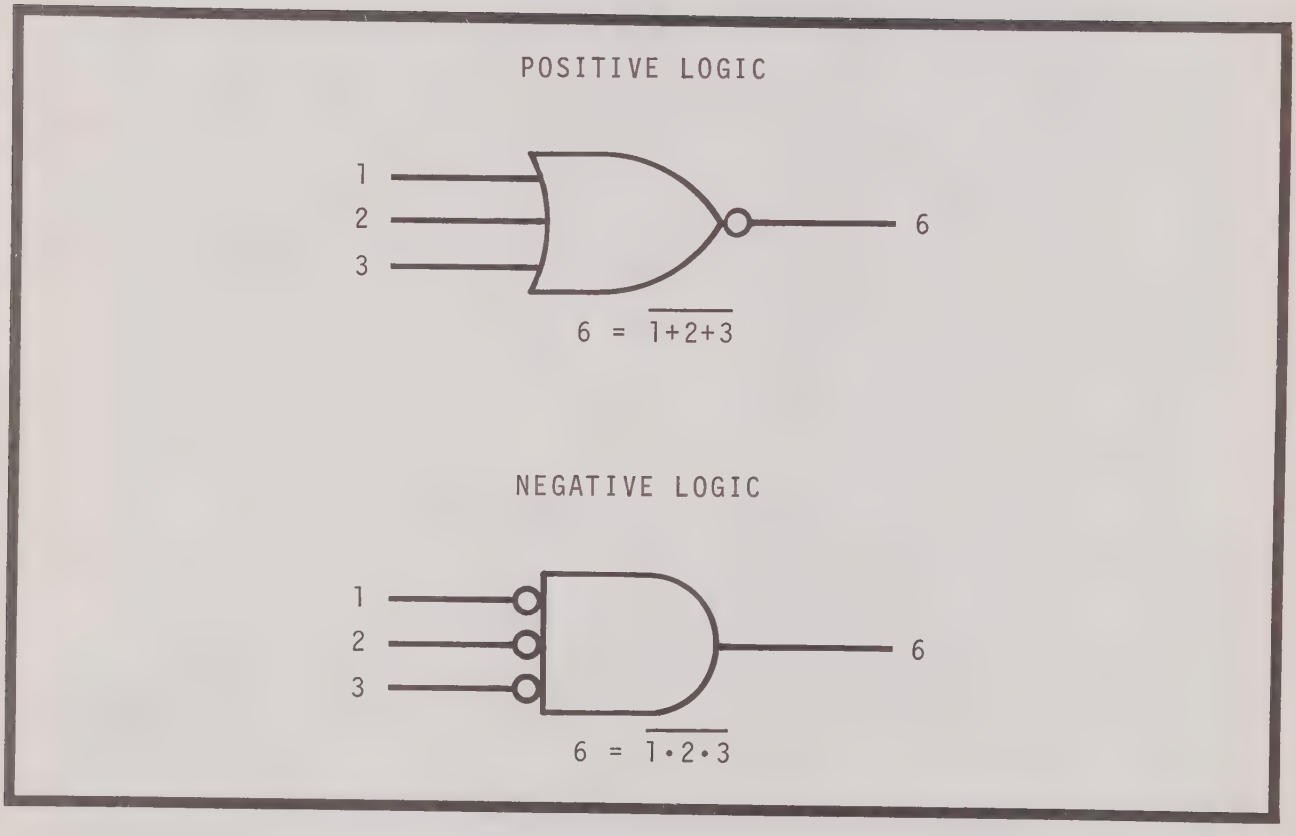
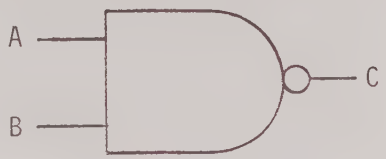


FIGURE 4.2 LOGIC SYMBOLS

A	B	C
H	H	L
H	L	H
L	H	H
L	L	H

NAND



$\overline{A \cdot B} = C$

INV. OR

$\overline{A} + \overline{B} = C$

A	B	C
H	H	L
H	L	L
L	H	L
L	L	H

INV. AND

$\overline{A} \cdot \overline{B} = C$

NOR

$\overline{A + B} = C$

A	B	C
H	H	H
H	L	L
L	H	L
L	L	L

AND

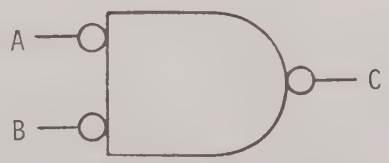
$A \cdot B = C$

INV. NOR

$\overline{A} + \overline{B} = C$

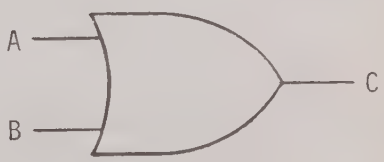
A	B	C
H	H	H
H	L	H
L	H	H
L	L	L

INV. NAND



$\overline{A} \cdot \overline{B} = C$

OR



$A + B = C$

FIGURE 4.3 MODEL 6153-50 CIRCUIT LOGIC SYMBOLS

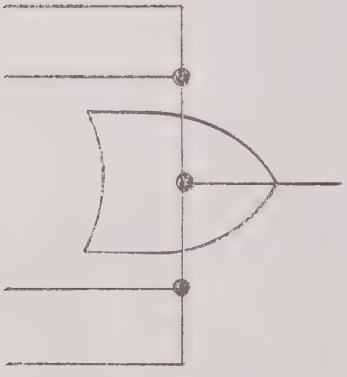
A	B	C
H	H	L
H	L	H
L	H	H
L	L	L

EXCLUSIVE OR

$$(A + \overline{B}) \cdot \overline{(A \cdot B)} = C$$

$$(A \cdot \overline{B}) + (\overline{A} \cdot B) = C$$

DOT OR



DOT AND

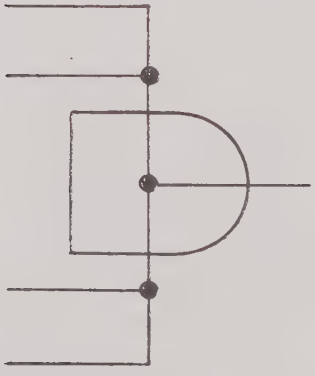


FIGURE 4.3 MODEL 6153-50 CIRCUIT LOGIC SYMBOLS (CONT'D)

the low end of resistor R10 to resistor R1 and capacitor C1. Resistors R7, R9 and R10 form a 100:1 voltage divider, presenting the Amplifier section with 1/100 of the input signal.

2) AMPLIFIER

Field effect transistor (FET) Q1A provides impedance matching between the input attenuator circuit and one side of differential amplifier Q3, Q4. It also serves to increase the current drive to this amplifier due to the impedance change. Field effect transistor (FET) Q1B simultaneously couples the trigger level signal to the other input of differential amplifier Q3, Q4.

The out-of-phase signals from differential amplifier Q3, Q4 are buffered by emitter followers Q9 and Q10; then, are fed to the output shaper section.

3) OUTPUT SHAPER

The output shaper is a conventional Schmitt circuit consisting of transistors Q5 and Q6 followed by emitter follower Q7. Transistor Q7 isolates and translates to a MECL level for further buffering by U1. Inversion is accomplished in the gate package. Transistor Q8 is a voltage translator to provide a gate signal to U1. When a positive level appears at Pin 24, the signal is passed through U1. When at zero, the signal is inhibited at U1.

4.4.2 10 MHz Amplifier - A18, A19 (Schematic 39328)

The "B" and "C" INPUT circuits are identical printed circuit boards, each consisting of three distinct operating circuits:

The Attenuator section is front panel switch-controlled and may be remotely programmed to present the Amplifier section with a signal which is equal to; 1/10 of; or 1/100 of the input signal, while maintaining a constant 1 MΩ load on the input connector. The DC-AC remote selection network is also incorporated into the Attenuator section.

The Amplifier section converts the high-impedance, single-ended input to a low-impedance, differential output of sufficient amplitude to activate the differential input trigger circuit of the shaper.

The Shaper section inparts a uniform rise time and amplitude to the signals from the Amplifier section for use by the slope selection logic and marker outputs, which drive the function control logic.

1) ATTENUATOR

The signal from the input connector is coupled through the dc blocking capacitor C1. If dc operation is desired, DC-AC relay K1 may be energized, shorting capacitor C1. If an attenuation ratio of X1 has been selected, relay K2 is energized, connecting the signal directly through capacitor C19 to transistor Q1A. Relays K3 and K4 are open, thus presenting the Amplifier section with, essentially, the input signal. If the input signal exceeds ±5 volts, Zener diodes VR1 and CR2 will conduct, protecting the Amplifier

section from damage.

If an attenuation ratio of X10 is selected, relay K3 is closed and relays K2 and K4 are open. Relay K3 connects the low end of resistor R4 to ground. Resistors R2 and R4 form a 10:1 voltage divider, presenting the Amplifier section with 1/10 of the input signal. The combined resistance of R2 and R4 provide a 1 MΩ load to the input signal.

If an attenuation ratio of X100 is selected, relay K4 is closed and relays K2 and K3 are open. Relay K4 connects the low end of resistor R5 to ground. Resistors R2, R3 and R5 form a 100:1 voltage divider, presenting the amplifier section with 1/100 of the input signal. The combined resistance of R2, R3 and R5 provides a 1 MΩ load to the input signal.

2) AMPLIFIER

Field effect transistor (FET) Q1A provides impedance matching between the input attenuator circuit and differential amplifier Q2, Q3. Field effect transistor (FET) Q1B simultaneously couples the trigger level signal to the other input of differential amplifier Q2,Q3. The outputs from this amplifier are coupled to the inputs of differential amplifier Q4, Q5. Outputs from transistors Q4, Q5 are fed to Trigger Shaper Q6, Q7/Q8, Q9.

3) TRIGGER SHAPER

The Trigger Shaper (transistors Q6, Q7/Q8, Q9) is a differential-type trigger circuit that converts the outputs of the previous amplifiers into a rectangular waveform. With transistors Q6, Q7 providing positive current feedback, transistors Q8, Q9 form a trigger circuit with approximately 0.5 V of hysteresis. The outputs are connected to differential amplifier Q10, Q11, the positive or negative outputs of which, are selected by the SLOPE switch. When the SLOPE switch is in the positive position, the + SLOPE line is grounded; thus, logic element U1-11 is "off" and logic element U1-6 is turned "on". This permits the positive output from transistor Q11 to pass through logic elements U1-6 and U1-8.

When the SLOPE switch is in the negative position, the ground is removed from the + SLOPE line; thus, logic element U1-3 is "on" permitting the negative output from transistor Q10 to pass through logic elements U1-3 and U1-8.

4) "B" OR "C" MARKERS (OUTPUT)

Marker outputs are provided by logic elements U2-3, U2-11 and U2-8. Pulse markers are generated by the logic elements U2-3 and U2-11 (one-shot). A level of 0 to +4.5 V is provided at the output of logic element U2-8. These pulses are amplified by transistor Q12 which provides +12 V pulses, 1 microsecond in width from a 1 kΩ source.

4.4.3 200 MHz Decade and Gate - A12 (Schematic 39324)

This card contains four separate functional sections. These sections are: 1) Count Select Section, 2) Start/Stop Select Section, 3) Gate Section, and 4) High Speed Decade Section.

1) COUNT SELECT SECTION

The Count Select Section is comprised of logic element U1 and its attendant discrete components shown in the referenced schematic diagram. This circuitry selects one of four possible signal sources to be counted. If the output of the "A" amplifier, for example, is to be counted, the control line on Pin X is grounded and the control lines on Pins 17, 20, and 21 are raised to a positive level between 3 and 5 volts. This programming allows the "A" amplifier output, present on Pin 19, to pass through logic elements U1-3 and U8-14 to the clock input of the High Speed Decade. Simultaneously, the time base, 100 MHz multiplier, and frequency extender signals are inhibited from access to logic element U8-14. Each of the four signals may be programmed in the same manner, (i.e.) ground the control line associated with the signal of interest and maintain a positive level on the other three control lines.

2) START/STOP SELECT SECTION

The Start/Stop Select circuitry includes logic elements U5, U7, U9, U12, sections of U2, U6, and U11, transistors Q1, Q2, Q3 and associated discrete components shown in the referenced schematic diagram. This circuitry selects one of five possible signal sources to control the gate length. Transistors Q2 and Q3, along with logic elements U2-8 and U2-11, control which slope of the signal from the "B" amplifier will activate the gate when the Period X1 function is selected by grounding Pin L. Grounding Pin L enables logic elements U11-3 and U11-6, allowing each to pass to the Gate Section, signals received from logic element U9. The signal from the "B" amplifier is converted from T^2 logic levels to ECL logic level by inverting transistor circuit Q1. The signal is inverted again in logic element U11-8 to reestablish the slope of the signal. This signal is fed to logic element U5-1 which provides two signals that exhibit a 180° phase relationship. These two signals are connected to logic element U9. The Slope Selection circuitry enables the various sections of logic element U9, such that it may pass the proper phase signal to logic elements U11-3 and U11-6.

If the gate length is to be determined by the time base signal, Pin 8 is raised to a positive level of between 3 and 5 volts. This enables logic element U6-8, allowing the time base signal present on Pin U to pass. The output of U6-8 is capacitively coupled to the input Gate Section. The inputs to logic elements U12-1 and U12-13 are dc-biased to approximately -2 volts, in order that a positive transient

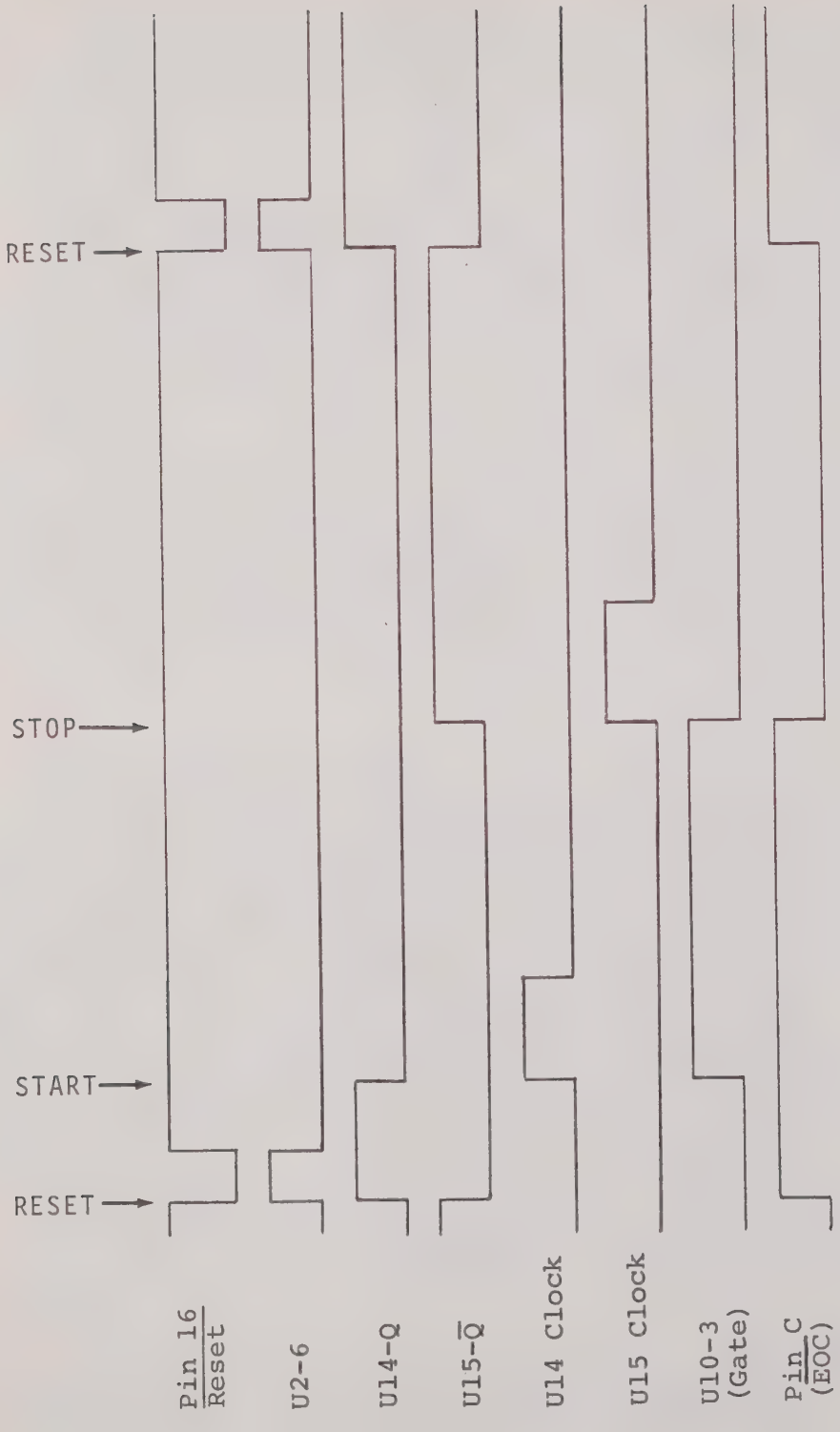


FIGURE 4.4 MAIN GATE TIMING DIAGRAM

of +2 or more volts coupled to each element from logic elements U6 or U7, will cause a positive transient on the outputs. These positive transients are transmitted to the Gate Section as Start/Stop signals.

3) GATE SECTION

The Gate Section includes logic elements U8-3, U10, U14 and U15 (see Figure 4.4, Main Gate Timing Diagram). Flip-flops U14 and U15 receive the Start/Stop signals from the Start/Stop Select Section and generate a level, the duration of which, is equal to the elapsed time between the Start and Stop signals. When this level (at U10-3) is applied to logic elements U8-3 and U10-14, the High Speed Decade Section is allowed to run at the rate of the clock signal supplied from the Count Select Section. When the gate level is removed (end of gate time), the High Speed Decade is inhibited from running. The gate level, when present, is converted to T^2 logic level in one section of logic element U16 and presented to Pin H. Flip-flop U15 is clocked by the Stop signal from the Start/Stop Select Section and is reset at the instrument reset time, thus generating a level which exists between gate-off and reset. This level is termed $\overline{\text{E.O.C.}}$ (End-of-Count) and is converted to T^2 logic level in another section of logic element U16 for transmission to other circuits via Pin C.

Should a totalizing function be required of the Gate Section, Pin E is raised to a positive level between 3 and 5 volts. This will cause flip-flops U14 and U15 to be held in a reset state and shift control of logic elements U8-3 and U10-14 to Pin D via logic element U3-3. Thus, when Pin D is grounded, the High Speed Decade Section is allowed to run at the rate of the clock signal supplied by the level between 3 and 5 volts, the High Speed Decade Section is inhibited. Since flip-flop U15 is maintained in its reset state by the level on Pin E, no $\overline{\text{E.O.C.}}$ is generated.

4) HIGH SPEED DECADE SECTION

The High Speed Decade Section includes: flip-flops U13, U18, U19 and U20; logic elements U4 and U17; and Q4, Q5, with their attendant descrete components. (See Figure 4.5, 200 MHz Decade Timing Diagram.)

The decade proper is formed by flip-flops U13, U18, U19 and U20 connected in a conventional ÷2, ÷5 configuration. Flip-flop U13 is a high speed "D" type circuit connected so that it will toggle freely. This forms the ÷2 portion of the decade. The ÷5 portion is formed by "JK" type flip-flops U18, U19 and U20. These are connected so that the "2" bit (U18) is permuted by the action of the "8" bit (U20). The output coding of the decade is a conventional positive true 1-2-4-8 derived from the Q outputs of the four flip-flops. The Q outputs of the 1, 2, and 4 bits are connected directly to level converter U17. The $\overline{Q}$ output of the 8 bit is inverted in logic element U4-8 and connected to the fourth

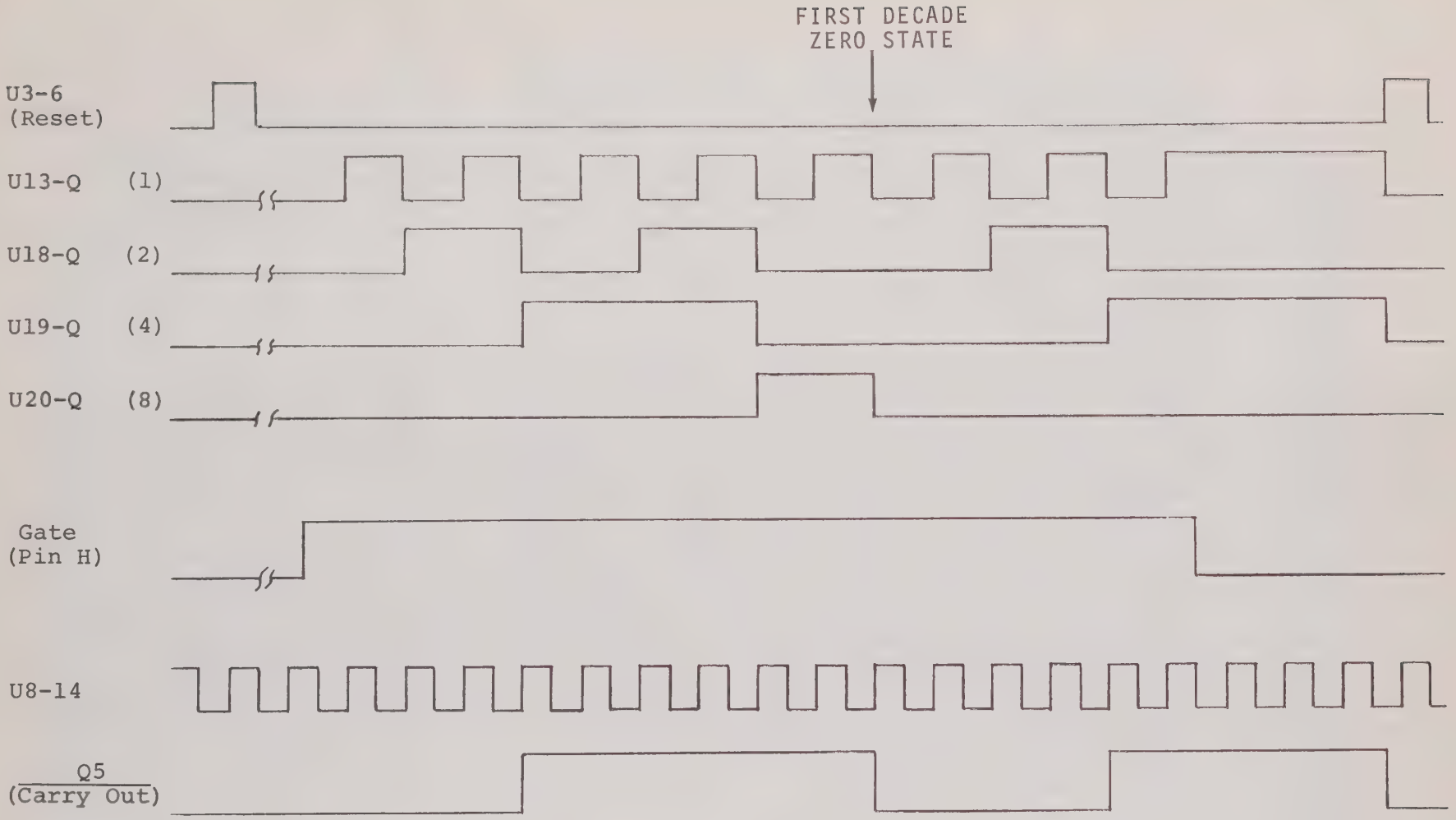


FIGURE 4.5 200 MHz DECADE TIMING DIAGRAM

section of level converter U17. The outputs from level converter U17 are at DTL logic levels and reflect the static state condition of the decade proper. The Carry output of the decade (Pin CC) is derived from an "OR" condition of the 4 and 8 bits. This is accomplished in logic element U4-11. This combined signal is used to drive high-speed level converter Q4 which is buffered by Q5. The Carry output signal has a 6 to 4 level ratio and is at T^2 logic levels. Reset is applied to the decade from Pin 16 via logic element U3-3.

4.4.4 Legend Logic - A8 (Schematic 39332)

This circuitry provides a BCD output to the Readout (A1) card which decodes and displays the proper units of measure as selected by the FUNCTION and RESOLUTION switches. Coding is accomplished through a series of NAND-NOR logic gates. Logic summation, complement generation, as well as asterisk generation is accomplished on this assembly. Table 4.2 describes the BCD outputs of the card for the units of interest.

4.4.5 Decimal Logic - A9 (Schematic 39336)

This assembly provides a BCD output to the Readout (A1) card which decodes and displays the decimal in the proper location as selected by the FUNCTION and RESOLUTION switches. Coding is accomplished through a series of NAND-NOR logic gates. Logic summation, complement generation, and decimal location, in the form of a BCD code, is accomplished on this assembly. Table 4.3 indicates the BCD outputs of the card for a specified decimal location.

4.4.6 Function Control - A11 (Schematic 39340)

The assembly is comprised of two major circuit groups: function logic summation and selection; automatic/manual recycle and data-transfer pulse generation.

4.4.6.1

Circuitry of the first group combines, for signal/gate selection and control purposes, the selected positions of the FUNCTION and RESOLUTION switches.

The gates for this logic are found primarily on assemblies A1, A10, and A12. As an example, the following gate controls are developed:

1) When in the P/R X1 mode (not Test) and (not Ratio), PER X1 + TEST Pin 10 will be negative.

2) When in the $\overline{\text{COUNT A}}$, $\overline{\text{RATE A}}$ or $\overline{\text{RATIO}}$ modes (but not in Test or 10 ns), the $\overline{\text{COUNT A AMP}}$, Pin 19, will be negative.

3) If RATE D, 10 ns, $\overline{\text{TEST}}$, and COUNT A modes have not been selected, $\overline{\text{COUNT T.B.}}$, Pin 17, will be negative.

TABLE 4.2 LEGEND LOGIC OUTPUT CODE

MEASUREMENT UNITS	BCD WEIGHT/OUTPUT PINS			
	1 / P11	2 / P2	4 / P7	- / P21
* (Invalid Switch Position)	0	0	0	1
MHz	1	0	0	-
kHz	0	1	0	-
sec	1	1	0	-
ms	0	0	1	-
µs	1	0	1	-
Gate	Driven from Function Control Board			

TABLE 4.3 DECIMAL LOCATION OUTPUT CODE

DECIMAL LOCATION	BCD WEIGHT/OUTPUT PINS		
	1 / P17	2 / P18	4 / P"B"
10^0	0	0	0
10^1	1	0	0
10^2	0	1	0
10^3	1	1	0
10^4	0	0	1
10^5	1	0	1
10^6	0	1	1
10^7	1	1	1

4) If $\overline{\text{RATE A}}$ or RATE D, and $\overline{\text{TEST}}$ modes are selected, $\overline{\text{COUNT}}$ 100 MHz Pin 18, will be negative. When the 10 ns, $\overline{\text{RATE A}}$ or RATE D, $\overline{\text{RATIO}}$ or $\overline{\text{TEST}}$ modes are selected, $\overline{\text{COUNT}}$ 100 MHz Pin 18, will be negative.

5) If the $\overline{\text{COUNT}}$ A or $\overline{\text{HOLD}}$ function is selected, the cross-coupled NAND gates U6-8 and U6-6 will flip and produce a positive level at Pin U6-8. This state will exist until some function other than $\overline{\text{COUNT A}}$ or $\overline{\text{HOLD}}$ is selected.

4.4.6.2

The control pulse generation requirements are as follows:

1) Resetting of the instrument to generate a time zero reference.

2) Transferring of the accumulated data to storage and display at the correct time.

Reset occurs when an E.O.C. (End-of-Count) negative condition exists at Pin 3 (assuming the $\overline{\text{INHIBIT RESET}}$, Pin S, to be positive). In this condition the base of transistor Q1 will be negative (ground). This permits the charging of capacitors C4, and C6 dependent in part on the condition of the Fast-Slow switch, at a rate determined by the Recycle Rate potentiometer and resistor R12. When the intrinsic standoff voltage of transistor Q2 is reached, a negative pulse is created at the junction of resistor R14 and capacitor C7. This pulse triggers the one-shot comprised of logic elements U13 and U12. The signal is inverted and buffered for distribution by logic elements U11, and transistors Q3 and Q4. A negative (ground) signal at Pin S will prevent this automatic recycle from occurring.

The reset pushbutton signal is conditioned and shaped by inverter U13, along with one-shot U14-6 and U12-3. The output on Pin V is returned to Pin X as the $\overline{\text{DEMAND RESET}}$. The one-shot is used to prevent a multiplicity of pulses from occurring due to the mechanical nature of pulse activator S3.

Transfer action occurs if the Storage switch is in the "on" condition and the instrument is not in Count or Hold; the output of logic element U12-11 will be negative. Inverter U13-3 will present to gate U11-6 a positive input. $\overline{\text{DEMAND RESET}}$ line Pin X will be high as is the quiescent state of the one-shot output U14-3. Therefore when a differentiation of the negative-going E.O.C. signal occurs, it triggers one-shot U14-11 and U14-3, with a resulting transfer pulse at the output of U11-6. The positive bias to transistor Q5 is removed by inverter-driver U14-8 and a positive transfer pulse appears at TRANSFER output Pin R.

With the storage switch in the "off" position, Pin 15 is negative (ground) causing the output of logic element U12-11 to be positive; the output of inverter U13-3 to be negative; the output of gate U11-6 to be positive; and, the output of inverter-driver U14-8 to be negative. This condition holds the output of transistor Q5 in a positive state, ensuring continuous transfer of data as it changes.

4.4.7 Time Base - A10 (Schematic 39344)

This assembly provides two major functions:

1) a. Provides a time selectable in factors of ten which is referenced to the internal frequency standard.

   b. Provides a scaled frequency in factors of ten which is referenced to the internal frequency standard.

   c. Provides frequency division in factors of ten which is referenced to the input frequency at the "A" INPUT.

2) a. Allows for Period and Ratio averaging by accumulating in factors of ten, the number of events to be averaged.

   b. Provides a continuous 1 kHz frequency for use with the Automatic Computing Transfer Oscillator (ACTO*).

The divide chain, comprised of integrated circuits U1 through U8, accepts inputs as controlled by gate U18. These inputs are scaled by a factor of ten and are available for selection by gates U16, U15 and U19-6. The selected output is inverted by gate U14-6 and is available for timing purposes, or as a known frequency for TIM or Period measurements. The same gates are used for scaling an input frequency with the buffered output appearing at U14-3 for the Time Base SCALE OUTput at the rear panel. Gate U17-8 is activated during Rate D operation to remove decade divider U1 from the count chain.

When the EXTernal/INTernal TIME BASE switch is in the EXTernal position, gate U15-8 is activated and the external selected frequency is available as a time-frequency standard.

The divide chain, comprised of integrated circuits U9 through U13, accepts inputs from gates U19-3, U19-8 and U19-11. Gate U19-3 is activated for all Rate functions and supplies a continuous 1 kHz signal for the ACTO "N" computer circuit. When in the Period or Ratio mode the "B" amplifier is presented to this decade chain through gate U19-8. The output signals from the decade chain are available for selection by gates U21 and U22. Logic element U21-3 inverts and buffers the selected output for use in the instrument.

4.4.8 Attenuator Select - A6 (Schematic 39352)

This board assembly provides a means of interconnecting the front panel controls to the internal assemblies. When used in conjunction with the remote programming option for this instrument, different board assemblies are inserted in these positions to perform the Local-Remote function.

*ACTO - Registered T.M.

4.4.9 Function Select - A7 (Schematic 39800)

This assembly provides a means of interconnecting the front panel controls to the internal assemblies. Logic elements U1 and U2 generates the required logic summation to provide a ground closure for the Resolution switch.

4.4.10 10 MHz Oscillator A3 (Schematic 39356)

The assembly is composed mainly of two circuits:

1) A 10 MHz crystal-controlled oscillator.

2) Circuitry for comparing the phase of the oscillator with an unknown, but harmonically related signal for the purpose of deriving a dc control voltage that is proportional to the phase difference between the two signals.

The oscillator is basically of the Colpitts type with a 10 MHz crystal as an integral part of the feedback and frequency determining network. The oscillator is followed by appropriate buffers for distribution throughout the instrument. Frequency of the oscillator is controlled by capacitors C2, C3, and diode CR3.

The 10 MHz signal is divided by two and presented to sample diodes CR8 and CR9. The sample network is driven by integrated circuit U5-9 and logic element U3-3. The EXT/INT STD FREQuency INPUT signal is divided by two in integrated circuit U5-2; then, inverted in logic elements U3-6 and U3-11. An error voltage is developed at the junction of resistors R18 and R19 if the two signals are out of phase. This error voltage is amplified by amplifier U4 and applied to diode CR3 to correct the 10 MHz oscillator, keeping it harmonically related and phase-locked to the unknown input. Figure 4.6 describes the lock range of frequencies which are harmonically related.

4.4.11 100 MHz Multiplier - A4 (Schematic 39360)

The 100 MHz multiplier consists of: 1) a 10 MHz amplifier; 2) a times-five frequency multiplier; and 3) a times-two frequency multiplier. The frequency multipliers are cascaded to give a composite multiplication factor of ten.

Transistor Q3 circuitry inparts power amplification and some desired harmonic filtering to the 10 MHz signal received from the oscillator. The output of this circuit is coupled through capacitor C2 to the base of transistors Q1 and Q2. These transistors are connected in a complementary amplifier circuit to provide further power gain to drive the times-five multiplier.

The times-five multiplication is accomplished by tuning parallel tank inductor L2/capacitor C10 and inductor L3/capacitor C12 to 50 MHz. Coupling between these two circuits is provided by capacitor C11. The 50 MHz output from the circuit is applied to the base of transistor Q4. The Q4 collector tank, consisting of inductor L4 and capacitor C15, is tuned to 100 MHz. This 100 MHz signal is coupled through capacitor C18 to the tapped output matching tank inductor L5/capacitors C16, C17.

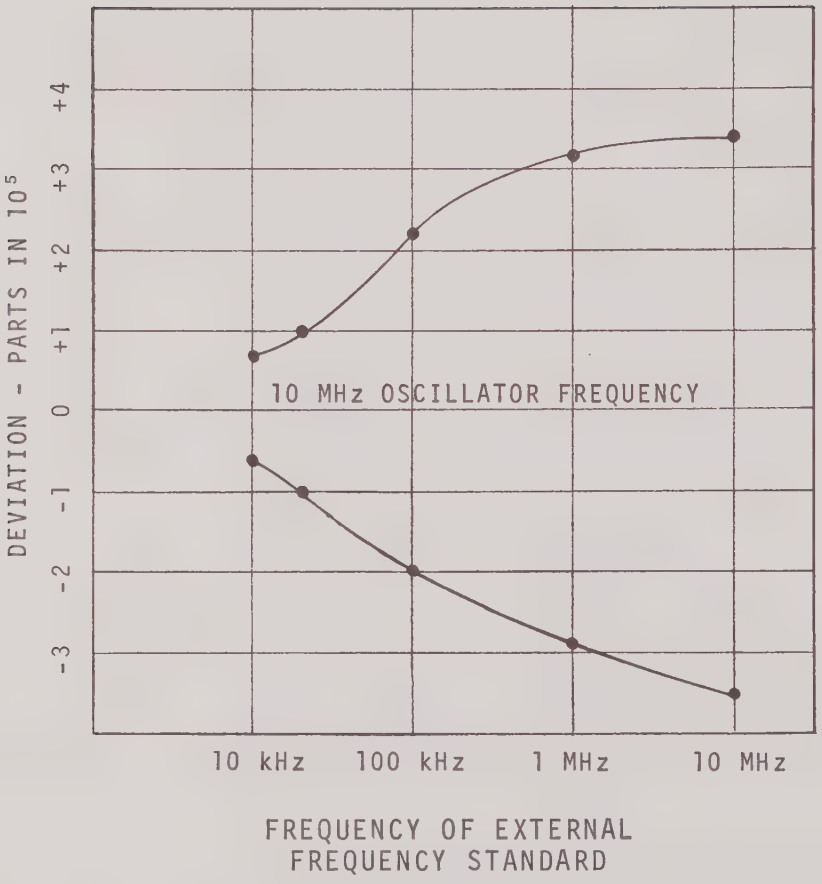


FIGURE 4.6 RELATIONSHIP OF 10 MHz OSCILLATOR DEVIATION vs EXTERNAL FREQUENCY STANDARD INPUT.

4.4.12 3 MHz Oscillator Power and Frequency Divider - A2 (Schematic 39364)

The assembly serves two functions:

1) Provides source of regulated power for the high-stability 3 MHz oscillator.

2) Provides for frequency division from 3 MHz to 1 MHz.

A reference voltage is developed by reference amplifier U1 as a function of the voltage at the junction of resistor R3 and R4, and the unregulated input voltage at Pin N. The output voltage is compared against the internal voltage reference, with the signal drive to series regulator Q1 being continuously monitored to maintain the output voltage at Pin L constant in amplitude.

The 3:1 frequency division takes place following buffer amplifier Q2. The high-stability oscillator produces a 3 MHz signal which is then divided down to 1 MHz to provide the suitable lock signal for the 10 MHz oscillator. Two binaries contained in integrated circuit U2 are interconnected to produce the division by three. The binaries are gated to an "off" condition by grounding Pin P when in the EXT STD FREQ INPUT switch position.

4.4.13 3 MHz Oscillator - U1

This unit consists of a sealed crystal oscillator and temperature-controlled oven. Any effort to open or repair this assembly in the field will void the applicable warranty on the unit. Defective units must be returned to the factory for service.

Power for this assembly is obtained from a separate power supply assembly (Assembly A2) which operates independent of the instrument power switch. Whenever the instrument is plugged into the appropriate power outlet, this separate power supply maintains the oven temperature constant, even when the instrument power switch is in the "off" position.

4.4.14 Automatic Computing Transfer Oscillator - "D" Input (Figure 4.7)

The Automatic Computing Transfer Oscillator (ACTO) operates by phase-locking a low-frequency oscillator to the applied RF input frequency and solving for the harmonic multiple "N". The counter time base is then expanded so that the instrument will count the low-frequency oscillator for a period equal to "N" times the selected time base. The result is a direct indication of the RF input frequency.

When the ACTO is in the phase-lock condition, the voltage-controlled oscillator (VCO) is an exact submultiple of the unknown RF input.

The low-frequency drive to the "B" channel mixer varies from the VCO frequency by precisely 1 kHz. Mathematically, the various frequencies are as follows:

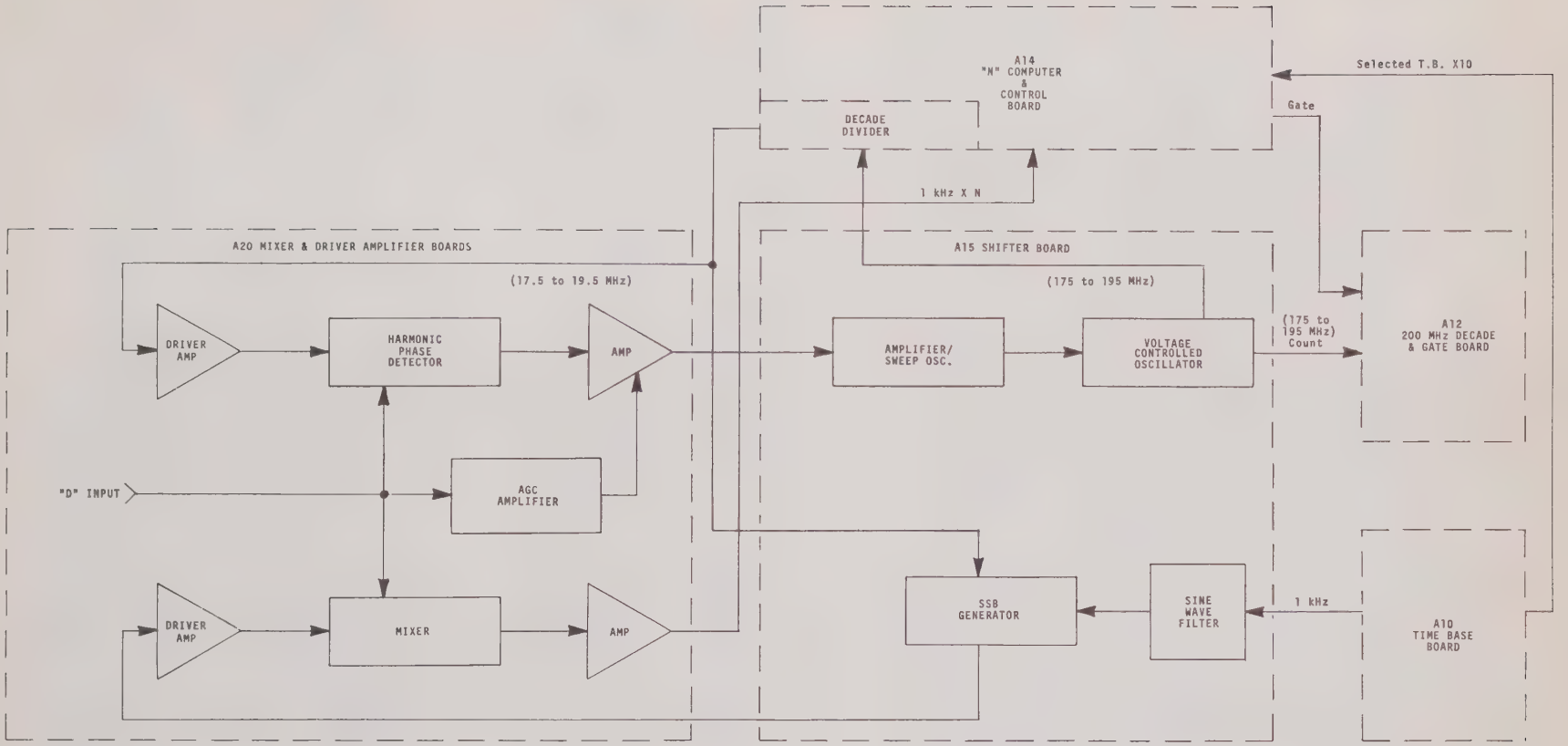


FIGURE 4.7 BLOCK DIAGRAM, AUTOMATIC COMPUTING TRANSFER OSCILLATOR (ACTO).

F = frequency of voltage-controlled oscillator.
N X F = RF input
N (F +1 kHz) = RF input + (1 kHz X N)

The output of the "N" channel mixer becomes 1 kHz X N. In order to directly indicate the RF input signal, "N" must be computed and the counter measurement period lengthened by the factor "N".

As illustrated in Figure 4.7, the ACTO incorporates a drive/amplifier, phase detector, amplifier/sweep oscillator, a voltage-controlled oscillator and decade divider to form a "phase-lock loop". The free-running sweep oscillator tunes the voltage-controlled oscillator over a band of frequencies, producing an output which varies in frequency between 175 and 195 MHz. This signal is divided by ten; then, applied to the harmonic phase detector through the driver/amplifier and is phase-compared to the RF input. When an exact oscillator harmonic is encountered, a dc voltage is generated which disables the sweep oscillator and locks the voltage-controlled oscillator to a submultiple of the input frequency. However, since the harmonic number (N) is unknown, it is not yet possible to measure the exact input frequency.

A second output from the decade divider is extracted and applied to a single-sideband generator. The generator is modulated at a 1 kHz rate, resulting in an output equal to the oscillator frequency shifted by 1 kHz. This signal is then applied to the mixer circuit, the output of which, is equal to 1 kHz X N.

Since the original 1 kHz modulation frequency and the 1 kHz X N are present, it is possible to compare the two frequencies digitally and extract the corresponding harmonic number (N). This is the function of the N compute and control circuit. After extracting N, the N compute and control circuit expands the time base period by the appropriate factor of N to provide a direct readout of the input frequency.

4.4.14.1 Mixer and Driver/Amplifier - A20 (Schematic 27988)

The voltage-controlled oscillator signal is shaped by transistor Q101 and Q102 to produce positive pulses across inductor L103. This output passes through emitter Q105 then drives the anode of step-recovery diode CR101. Due to the snap-off action of this diode, the comparatively slow-rising negative pulses developed by transistor Q101 become high-speed transients. Positive transients are present on the cathode and negative transients are present on the anode step-recovery diode CR101. These transients are differentiated by CR101 and R1/C102 and R2 to form very fast pulses, typically 0.5 nanosecond wide and 1.0 volt in amplitude.

The positive pulse is coupled to diode CR2 through capacitor C1, and the negative pulse is coupled to diode CR1 through capacitor C2. The RF to be measured is directly coupled to the junction of CR1 and CR2. A voltage is present at the junction of resistor R5 and R6 which is proportional to the phase difference between the RF input and a particular VCO harmonic contained in the pulses which drive diodes CR1 and CR2.

Since the signal present at the junction of resistors R5 and R6 is small (approximately 200 mV p-p), it must be amplified. To accommodate large variations in signal level, the gain of amplifier U1 is effectively controlled by the AGC amplifier through gain control FET Q3.

The circuitry described above has been for the "phase-lock loop" channel driver/amplifier. The "N" channel driver/amplifier (Q103, Q104, and associated components) is identical in operation. The output of the "N" channel mixer (junction of resistor R7 and R8) is applied to the gate of FET source follower Q2 which, in turn, drives amplifier/shaper U3. The output from amplifier/shaper U3 (1 kHz X N) is connected out through Pin X.

Automatic control of amplifier gain (AGC) is accomplished as follows: The RF input level is detected by diode CR5. The resultant dc is amplified by amplifier U2, which biases gain control FET Q3. By varying the bias on the gate of Q3, the dynamic impedance from source to drain can be controlled; therefore, the gain of the amplifier will be automatically adjusted by the amplitude of the RF signal being measured.

As a harmonic of the voltage-controlled oscillator (divide-by-ten) approaches the input frequency, the difference frequency decreases. When the difference frequency falls below 1 MHz, the low-bandpass amplifier passes and amplifies the signal. The output is directly coupled to Pin C. The voltage, developed across resistor R5 nullifies the drive to the sweep oscillator, resulting in a dc output. This dc voltage holds (or locks) the VCO at a frequency, the harmonic of which, equals the RF input; thus, accomplishing phase lock.

4.4.14.2 Sweep Oscillator - A15 Shifter (Schematic 39368)

The sweep oscillator generates the triangular waveform that sweeps the voltage-controlled oscillator (VCO). Transistors Q1 and Q2 form a binary switch. In the following example and with no input present, transistor Q1 conducts while Q2 is held "off". Current flow through resistor R4 and transistor Q1 causes amplifier U1 to invert and, due to the feedback network (capacitor C1 and resistor R3), produce a linear rise in voltage at the output. When the output voltage reaches +10 volts, VR1 conducts, forward biasing transistor Q2. Transistor Q2 conducts while transistor Q1 is held "off". This action causes amplifier U1 to draw current from the positive supply through resistor R1, driving the output in a negative direction. The output continues to drive in a negative direction until it reaches -5 volts. At -5 volts, transistor Q2 is turned "off" and transistor Q1 is turned "on"; thus, repeating the cycle. The net effect of this circuit is a triangular waveform varying between +10 volts and -5 volts as seen at TP1.

4.4.14.3 Voltage-Controlled Oscillator - A15 Shifter (Schematic 39368)

The triangular waveform is now applied to the base of emitter follower Q3, and into the voltage-controlled oscillator (VCO) frequency

determining tank circuit (CR4, CR5 and L2). CR4 and CR5 are "varicap" type diodes with a capacitance characteristic inversely proportional to the bias applied. Figure 4.8 depicts a typical "varicap" curve.

As illustrated, the varicap curve is nonlinear. To compensate for this nonlinearity, corrective networks consisting of a resistor and a diode in series (R9, CR1 and R11, CR2) are placed across the triangular wave generator load resistor R10. The effect of these two networks is a nonlinear curve which opposes the varicap curve, resulting in a more linear function (see Figure 4.9).

4.4.14.4 Single-Sideband Generator - A15 Shifter (Schematic 39368)

The divide-by-ten output from the voltage-controlled oscillator (Pin Z out to "N" computer divider and returned through Pin X), must be shifted in frequency by 1 kHz in order to properly drive the "N" channel harmonic mixer and must be sinusoidal to drive the single-sideband generator.

This signal is filtered by resistor R24, capacitor C16, and inductor L6 to reduce harmonic distortion, and is then split into two components, separated in phase by 90°. Phase separation is accomplished by an LR phase-lag circuit (L10, R50) and CR phase-lead circuit (C30, R49). The resultant signals are used to drive the balanced modulators in integrated circuit U2.

Simultaneously, a 1 kHz signal from the time base (Pin F) is routed to the base transistor Q7. Transistor Q7 inverts and amplifies the signal. A "twin-T" notch-filter on the collector of transistor Q7 is tuned to 1 kHz, passing all other frequencies. FET Q6 provides a negative feedback path for all frequencies except 1 kHz. The remaining 1 kHz signal, at the collector of transistor Q7, is now capacitively coupled to the base of inverting amplifier Q8. Two separate 1 kHz signals, 90° out of phase, are extracted from Q8. The noninverted signal is from the emitter circuit and the 90° leading signal is from the collector circuit. These signals are capacitively coupled to the balanced modulators. The first modulator removes the carrier frequency and the second modulator removes one sideband, resulting in a single sideband. The net effect of this action is the shifting of the carrier frequency by 1 kHz. The balanced modulators (U2) are a pair of differential amplifiers utilizing the carrier to drive the common mode input. Integrated circuit U3 sums the outputs of the balanced modulators and converts them to a single output available at Pin 3 (connector J3).

4.4.14.5 "N" Computer - A14 (Schematic 39372)

The "N" Computer serves three basic functions:

1) Compute which harmonic of the voltage-controlled oscillator is mixing with the RF input to cause phase lock.

2) Expand the selected time base by the computed "N" number (harmonic number).

3) Provide a scale-of-ten divider on the output of the voltage-controlled oscillator.

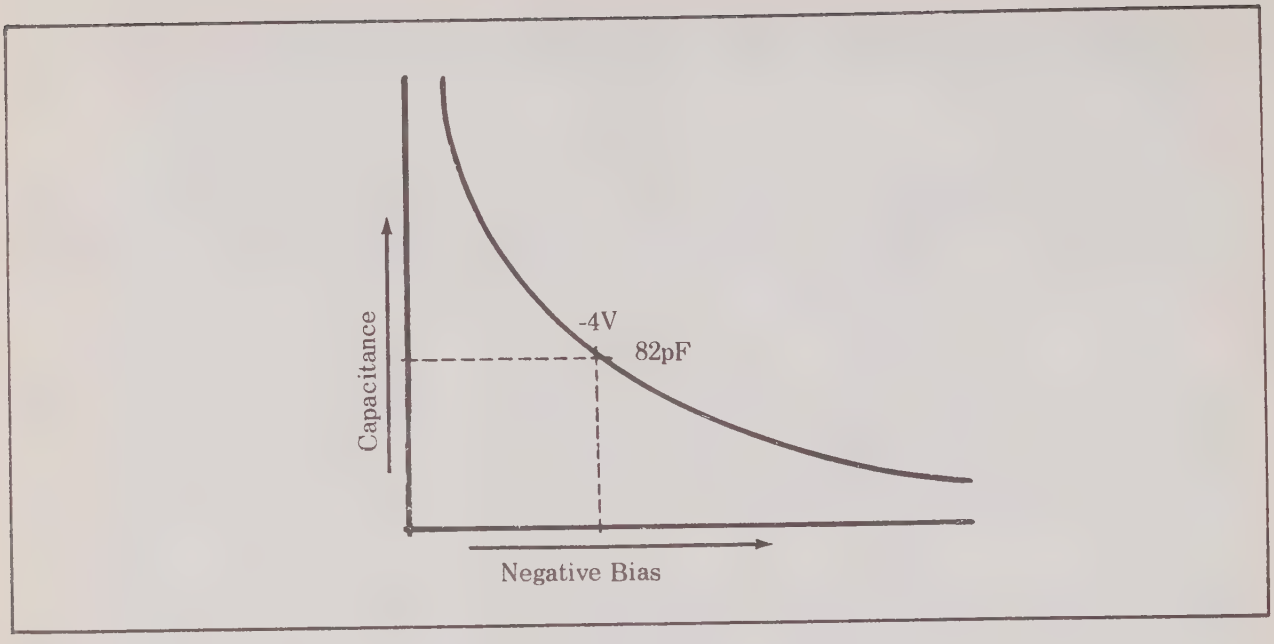


FIGURE 4.8 TYPICAL VARICAP CURVE

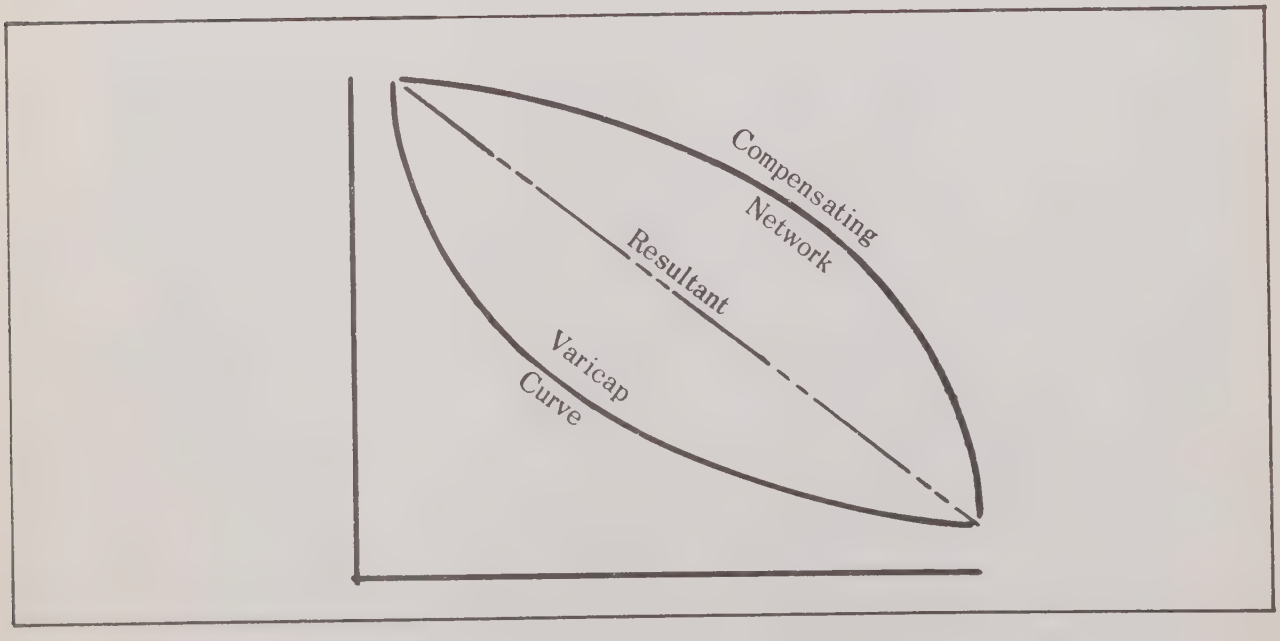


FIGURE 4.9 IDEAL VARICAP CURVE

1) COMPUTE N CIRCUITRY

The Compute N Circuitry consists of decade U4, dual "JK" type flip-flop U1, reversing accumulators U2 and U3, and logic elements U12-8, U12-11, and U14-11.

When the mixer has "locked" the voltage-controlled oscillator to the RF input, a signal, the frequency of which is equal to 1 kHz X N, is applied to Pin 17 of the N Computer.

After the N Computer has been reset via Pin P, decade U4 starts counting at a 1 kHz rate from a constant 1 kHz signal supplied from the main counter time base via Pin E and logic element U12-8. When decade U4 has accumulated four of the 1 kHz pulses, Pin 8 rises to a positive level enabling dual "JK" type flip-flop U1.

Flip-flop U1 is connected as a ÷4 circuit and is clocked by the 1 kHz X N signal applied at Pin 17. The resultant output from Pin 9 of flip-flop U1 is applied through logic element U11-6 to the down-count input of reversing accumulator U2. Flip-flop U1 is held enabled for precisely four milliseconds as determined by the 1 kHz input and decade U4.

At the end of the four millisecond period, flip-flop U1 is disabled, and the number of counts stored in reversing accumulators U2 and U3 is equal to the harmonic number of the voltage-controlled oscillator mixing with the RF input (N number).

2) TIME BASE EXPANSION CIRCUITRY

The Time Base Expansion Circuitry includes dual "D" type flip-flop U5 and logic elements U13 and U14.

After the Compute N circuitry has been disabled by the action of decade U4, the Time Base Expansion Circuitry is enabled (also by decade U4) via logic element U12-11. The first time base pulse appearing at Pin L following the enable signal from logic element U12-11, sets Pin 8 of flip-flop U5 to its positive state, enabling logic element U14-8. The next succeeding time base pulse to arrive at Pin L is coupled through logic element U14-8 to Pin N and is used as a start gate signal by the main counter. The trailing edge of this same time base pulse is transmitted to the up-count input of reversing accumulator U2.

When a number of time base pulses equal to the N number previously stored in reversing accumulators U2 and U3 have been received, reversing accumulator U3 will generate a "carry out" pulse which sets the "RS" type flip-flop formed by interconnected logic elements U13-8 and U13-11. This enables logic element U14-3, allowing the next time base pulse arriving at Pin L to be conducted to Pin M for use by the main counter as a stop gate signal. The stop gate is equal to the applied time base period times the N number.

3) SCALE-OF-TEN DIVIDER CIRCUITRY

The Scale-of-Ten Divider Circuitry consists of a ÷2, ÷5

decade formed by flip-flops U6, U7, U8 and U9,and logic element U1D.

The flip-flops are connected in a conventional ÷2, ÷5 configuration. Flip-flop U6 is a high-speed "D" type and is connected such that it will toggle freely, forming the ÷2 portion of the decade. The ÷5 portion of the decade is formed by "JK" type flip-flops U7, U8 and U9, connected so that the "2" bit is permuted by the "8" bit.

The "4" bit output is buffered by logic element U10-15 and presented to Pin 20 for use by the Shifter assembly. The decade is clocked by the signal from the voltage-controlled oscillator present at Pin 22 via logic element U10-2. The output of logic element U10-2 is also presented to Pin BB via logic element U10-14 for use by the main counter. This is the signal counted during the expanded gate time.

4.4.15 Readout - A1 (Schematic 39380)

This assembly consists of the following major circuit groups:

1) Display readout.

2) Display decoders and drivers.

3) Data storage.

4) Scaling decoders.

5) Units Driver.

6) Decimal Driver.

7) Off Scale (OS) indication driver.

8) Gate lamp driver.

9) Unallowable condition (*) indication driver.

The display readout includes eight in-line, horizontal tubes of the neon-filled cold-cathode discharge type. As the cathodes are grounded, the elements ionize the gas, thus producing the numerical display. Current through the tubes is limited by the anode resistors.

The display decoder and drivers (integrated circuits U11 through U19) accept a binary-coded decimal input and convert the information to a one-of-ten output suitable for grounding the display tube cathodes.

The data storage devices (integrated circuits U11 through U19) accept and store, on command, binary-coded decimal information. When the transfer line, Pin 10 of connector J1 is positive, the input states (Pins 2, 3, 4 and 5) are transferred to the four storage binaries in U11. If the transfer line is held positive (Storage switch S23, "off"),each change of state at the input is reflected at the output.

If the transfer line is held at the negative state (ground), the information contained in the binaries when the transfer line was high, will be retained. The storage devices supply BCD output assembly A21.

The scaling decoder decades (integrated circuits U20 through U27) are a chain of decade dividers. The chain is reset to zero by a positive-going level on Pin 14 of connector J2. The 10° decade is located on the A12 assembly.

The measurement units driver U28 accepts binary-coded decimal information from the Legend Logic Assembly A8 and converts it to one-of-six outputs suitable for lighting elements of the annunciator unit.

The decimal driver U10 accepts binary-coded decimal information from the Decimal Logic assembly A9 and converts it to one-of-ten outputs suitable for lighting the decimals contained within the display tubes.

Off-Scale (OS) indication is obtained by sensing the carry output of the last decade in the chain. When this output occurs it is inverted by U29-6 and applied to the clock input of a "D-edge" triggered binary (U30A). The Q output goes positive. NAND gate U29-11 is now conditioned so that at data transfer an input is applied to the set pin of U30B. This produces a positive output at the Q1 pin which turns "on" off-scale lamp driver Q3, providing a ground for the OS indication.

The reset pulse is inverted by U29-3 and applied to the reset pin of U30A. This produces a negative (ground) at the Q output pin. This change of state is not transferred to U30B until the next transfer pulse. If the register has not been exceeded, no change-of-state takes place in U30A. Therefore, the next transfer pulse returns the Q1 output of U30B to the negative (ground) condition and the OS lamp is extinguished.

The Gate lamp signal information is derived from the Function Control assembly A11 and represents the actual time the main count gate is open (or is an expansion of the gate length, in the case of short gate duration), to provide a visual indication that the gate is operating.

The asterisk (*) indicates an unallowable switch combination. The signal information is developed in the Legend Logic assembly A8. The indicator will light due to certain unallowable switch combinations (see Table 4.4).

4.4.16 BCD Output - A1A2 (Schematic 39376)

The assembly provides a means of interconnecting various BCD options from the stored information of the Readout (A1) to the BCD output connector J12. The board provides a 5 kΩ pullup resistor for each BCD line. Positive true logic is employed, however, to inhibit the automatic reset, a closure to ground is required. The EOC (end-of-count) or "Print Command" is either a positive-going or a negative-going signal output. All lines are TTL compatible. It should be

noted that the print command signals are from a +12 volt source through a 1 kΩ resistor to be compatible with certain printers.

4.4.17 Main Power - A13 (Schematic 39348)

The power supply circuits supply four regulated voltage outputs of +5 V, -5.2 V, +12 V and -12 V dc. It also supplies unregulated voltages of approximately +225 V dc and +9 V dc.

The voltage regulator circuits make use of integrated circuit regulators and series pass transistors. The +12 V and -12 V dc supplies have independent voltage regulators; the +5 V supply requires +12 V for the reference supply and the -5.2 V supply requires +5 V for its reference supply. This is necessary because the integrated circuit regulators have a 7 V reference element.

TABLE 4.4 UNALLOWABLE SWITCH SETTINGS

RESOLUTION (Pushbutton)	FUNCTION (Switch)
Ratio	TIM RATE A RATE D
10 ns	RATE A RATE D
.1 μs	RATE A RATE D
10 seconds	TIM X1 X10 $X10^2$ $X10^3$ $X10^4$ $X10^5$

CHAPTER 5
MAINTENANCE

5.1 INTRODUCTION

This chapter contains procedures for adjustment and calibration of the Model 6153-50. It also contains troubleshooting and repair information to aid the user in maintaining the instrument in proper operating condition. Whenever a Systron-Donner instrument requires service, the nearest S-D representative should be contacted. He can provide field service, or arrange factory returns, when necessary. Address all inquires on operation or application to your nearest sales representative; or,Sales Manager:

SYSTRON-DONNER CORPORATION
CONCORD INSTRUMENT DIVISION
888 Galindo Street
Concord, California 94520
Phone: (415) 682-6161
TWX: 910-481-9479
Cable: SYSTRONDONNER

Specify both model and complete serial number in all correspondence.

5.2 ASSEMBLY DESIGNATIONS

Table 5.1 lists for reference purposes, information concerning the P.C. board assemblies used in this model.

TABLE 5.1 MODEL 6153-50 ASSEMBLY
CROSS-REFERENCE INFORMATION

Ass'y #	Nomenclature	SD Part #	Schematic #	Page #
A1	Readout	39383	39380	7-15
A2	3 MHz Osc./ Freq. Div.	39367	39364	7-17
A3	10 MHz Osc.	39359	39356	7-19
A4	100 MHz Mult.	39363	39360	7-21
A6	Attenuator Select	39355	39352	7-23
A7	Function Select	39803	39800	7-25
A8	Legend Logic	39335	39332	7-27
A9	Decimal Logic	39339	39336	7-29
A10	Time Base	39347	39344	7-31
A11	Function Control	39343	39340	7-33
A12	200 MHz Decade & Gate	39327	39324	7-35

TABLE 5.1 (Cont'd)

Ass'y #	Nomenclature	SD Part #	Schematic #	Page #
A13	Main Power	39351	39348	7-37
A14	N Computer	39375	39372	7-39
A15	Shifter	39371	39368	7-41
A16	200 MHz Amp.	39323	39320	7-43
A18	10 MHz Amp.	39331	39328	7-45
A19	10 MHz Amp.	39331	39328	7-45
A20	Mixer/Cable	39784	27988	7-49
A1A2	BCD Output	39379	39376	7-51
U1	3 MHz Osc.	33428	-	-

5.3 TEST EQUIPMENT

Table 5.2 lists the minimum test equipment inventory capable of supporting the maintenance of this instrument. In the event these specific items are not available, units of equal,or greater accuracy and capability may be used.

TABLE 5.2 TEST EQUIPMENT
FOR MODEL 6153-50

Nomenclature	Characteristics	Recommended Type
Freq. Error Expander	Expansion to 10^3	Tracor Model 527A
Oscilloscope	80 MHz Bandwidth, plug-in type	Tektronix Model 581A
Vertical Plug-in	10 mV/cm sensitivity	Tektronix Model 82
Sampling Plug-in	DC to 1 GHz	Tektronix Model 151
L. F. Generator	.02 Hz to 2 MHz	S-D Model 401
Sig. Gen.	10 Hz to 10 MHz	HP Model 651B
Sig. Gen.	10 MHz to 480 MHz	HP Model 608C
Sig. Gen.	450 MHz to 1230 MHz	HP Model 612A
Sig. Gen.	0.8 GHz to 2.4 GHz	HP Model 8614A
Sig. Gen.	1.8 GHz to 4.5 GHz	HP Model 8616A
Digital Voltmeter	±0.1% AC,DC	S-D Model 7000A
Freq. Std.	Stability $<2 \times 10^{11}$ per month	General Technology Model 304B
Autotransformer	Variable from 103 V to 127 V ac	Superior Model UC1M

TABLE 5.2 (Cont'd)

Nomenclature	Characteristics	Recommended Type
Connector	BNC "T" (2) req'd	
RF Millivoltmeter	1 mV to 3 V, 10 kHz to 2 GHz	HP Model 411A
Termination (50Ω)	Male to Female BNC	
Cable (set)	BNC to BNC cable; N to N cable	S-D 10338 S-D W0094
Electronic Counter	DC to 200 MHz	S-D Model 6153
Pulse Generator	35 ns, 0.3 V to 10 V, 10 MHz	S-D Model 101

5.4 ASSEMBLY AND CONNECTOR PIN LOCATION

The top and bottom views of the counter are shown in Drawings 39641, 39187, and 39188. Shown are the location of assemblies, chassis parts and connectors. Throughout the test, connections to assemblies are referred to in abbreviated form. For example, a connection to A7 Pin 9 is indicated as A7(9).

5.5 IN-CABINET PERFORMANCE CHECK

The performance test data sheet, Table 5.7 may be used for operational checkout of the instrument. In addition, it may also find usage for incoming inspection tests; as a permanent record of initial performance; as a plan to locate defective parts; for routine calibration records; and, as correlation information after repairs or service.

5.5.1 Rate A Measurements ("A" INPUT Connector)

1) DC Input: Range 0 to 200 MHz, dc-coupled.

   a) Set counter controls as follows:

FUNCTION	Rate A
RESOLUTION	10 Hz
ATTENUATOR	X1
DC-AC	DC
LEVEL	Preset
SLOW-FAST	Slow
RECYCLE RATE	Full clockwise
TEST	Deactivated

   b) Connect various signal generators to cover the range from 0 to 200 MHz. Use "T" connection and monitor with appropriate voltmeter to maintain 100 mV rms at input BNC. Record on data sheet.

c) Connect oscilloscope in place of voltmeter. Connect pulse generator to input, in place of signal generator. Set pulse width to 1 µsec, amplitude 300 mV p-p, repetition rate 1 MHz. Change amplitude to 1 V p-p. Use trigger level as required for both amplitudes. Note operation on data sheet.

2) AC Input: Range 10 Hz to 200 MHz, ac-coupled.

a) Repeat procedure described above in DC input, steps a, b, and c with DC-AC switch set in the AC position.

b) Vary generators from 10 Hz to 200 MHz.

c) Record on data sheet.

5.5.2 Rate D Measurements ("D" INPUT Connector)

1) Range: 200 MHz to 3 GHz (CW).

a) Set counter controls as follows:

FUNCTION	1 kHz
RESOLUTION	Rate D
SLOW-FAST	Slow
RECYCLE RATE	Full Clockwise
TEST	Deactivated

b) Connect various signal generators to cover the range from 200 MHz to 3 GHz. Maintain 50 mV rms at input to counter. Record on data sheet.

5.5.3 Frequency Resolution ("A" INPUT Connector)

a) Set counter controls as follows:

FUNCTION	Rate A
RESOLUTION	1 MHz
ATTENUATOR	X1
DC-AC	AC
LEVEL	Preset
SLOW-FAST	Slow
RECYCLE RATE	Full Clockwise
TEST	Deactivated

b) Connect 10 MHz output from test counter to "A" INPUT of counter under test.

c) Sequentially push each RESOLUTION position from 1 MHz to 0.1 Hz and observe counter readings; record on data sheet.

5.5.4 Test Rate A (Internal Time Base)

1) Counts 100 MHz to Resolution selected.

a) Use same test procedure indicated in Section 5.5.3, except that TEST pushbutton is activated.

b) Sequentially push each RESOLUTION position from 1 MHz to 0.1 Hz and observe counter readings; record on data sheet.

5.5.5 Scaling Measurements ("A" INPUT Connector)

1) Range: 0 to 150 MHz (10 through 10^9 factors).

a) Set counter controls as follows:

FUNCTION	Count A
RESOLUTION	10 to 10^9
ATTENUATOR	X1
DC-AC	AC
LEVEL	Preset
TEST	Deactivated
OUTPUT	Rear Panel (T.B. SCALE OUT)

b) Connect output from rear panel T.B. SCALE OUT to an oscilloscope,or another Model 6153-50.

c) Connect suitable 150 MHz signal to "A" INPUT". The scaled output when the scale factor 10 pushbutton is pressed will be 15 MHz. The scaled output will decrease by a factor of 10 for each higher order scale increment as shown in Table 5.7. Record on data sheet.

5.5.6 Period and Multiple Period Measurements ("B" INPUT Connector)

1) Range : 0 to 10 MHz.

a) Set counter controls as follows:

FUNCTION	Per Ratio X1
RESOLUTION	10 ns
ATTENUATOR	X1
DC-AC	AC
LEVEL	Preset
SLOW-FAST	Slow
RECYCLE RATE	Full clockwise
SLOPE	Positive (+)
SEP-COM	Sep
TEST	Deactivated

b) Connect 10 MHz output of test counter to "B" INPUT.

c) Set FUNCTION switch to P/RX1, $X10^2$, $X10^3$, $X10^4$, and $X10^5$. Observe all positions and record the results.

d) Connect T.B. SCALE OUTput of test counter to "B" INPUT. Turn RECYCLE RATE control of test counter to infinite position, and push 1 Hz RESOLUTION pushbutton. This will deliver a 1 Hz signal to the counter under test.

e) Sequentially push each RESOLUTION position from 10 ns to 1 sec. Observe and record the results on the data sheet.

NOTE: Observed readout accuracy will be a function of trigger level, frequency difference between counters, and ±1 count error.

5.5.7 Ratio and Multiple Ratio Measurements ("A" and "B" INPUT Connectors)

1) Range: "A" INPUT dc to 200 MHz; "B" INPUT 0 to 10 MHz. The "A" INPUT is used for the higher frequency (numerator); the "B" INPUT is for the lower frequency (denominator).

a) Set counter controls as follows:

FUNCTION	P/R
RESOLUTION	Ratio A/B
"A" ATTENUATOR	X1
"A" DC-AC	AC
"A" LEVEL	Preset
"B" ATTENUATOR	X1
"B" DC-AC	AC
"B" LEVEL	Preset
SEP-COM	Sep
SLOW-FAST	Slow
RECYCLE RATE	Full clockwise
TEST	Deactivated

b) Connect 200 MHz signal at 100 mV rms to "A" INPUT, from suitable generator.

c) Connect "B" INPUT of counter under test to T.B. SCALE OUT of the test counter. Push 100 kHz RESOLUTION button on the test counter for tests (1), (2), and (3) below. Push 100 Hz RESOLUTION button for remainder of tests. Monitor with oscilloscope.

5.5.4 Test Rate A (Internal Time Base)

1) Counts 100 MHz to Resolution selected.

a) Use same test procedure indicated in Section 5.5.3, except that TEST pushbutton is activated.

b) Sequentially push each RESOLUTION position from 1 MHz to 0.1 Hz and observe counter readings; record on data sheet.

5.5.5 Scaling Measurements ("A" INPUT Connector)

1) Range: 0 to 150 MHz (10 through 10^9 factors).

a) Set counter controls as follows:

FUNCTION	Count A
RESOLUTION	10 to 10^9
ATTENUATOR	X1
DC-AC	AC
LEVEL	Preset
TEST	Deactivated
OUTPUT	Rear Panel (T.B. SCALE OUT)

b) Connect output from rear panel T.B. SCALE OUT to an oscilloscope,or another Model 6153-50.

c) Connect suitable 150 MHz signal to "A" INPUT". The scaled output when the scale factor 10 pushbutton is pressed will be 15 MHz. The scaled output will decrease by a factor of 10 for each higher order scale increment as shown in Table 5.7. Record on data sheet.

5.5.6 Period and Multiple Period Measurements ("B" INPUT Connector)

1) Range : 0 to 10 MHz.

a) Set counter controls as follows:

FUNCTION	Per Ratio X1
RESOLUTION	10 ns
ATTENUATOR	X1
DC-AC	AC
LEVEL	Preset
SLOW-FAST	Slow
RECYCLE RATE	Full clockwise
SLOPE	Positive (+)
SEP-COM	Sep
TEST	Deactivated

b) Connect 10 MHz output of test counter to "B" INPUT.

c) Set FUNCTION switch to P/RX1, $X10^2$, $X10^3$, $X10^4$, and $X10^5$. Observe all positions and record the results.

d) Connect T.B. SCALE OUTput of test counter to "B" INPUT. Turn RECYCLE RATE control of test counter to infinite position, and push 1 Hz RESOLUTION pushbutton. This will deliver a 1 Hz signal to the counter under test.

e) Sequentially push each RESOLUTION position from 10 ns to 1 sec. Observe and record the results on the data sheet.

NOTE: Observed readout accuracy will be a function of trigger level, frequency difference between counters, and ±1 count error.

5.5.7 Ratio and Multiple Ratio Measurements ("A" and "B" INPUT Connectors)

1) Range: "A" INPUT dc to 200 MHz; "B" INPUT 0 to 10 MHz. The "A" INPUT is used for the higher frequency (numerator); the "B" INPUT is for the lower frequency (denominator).

a) Set counter controls as follows:

FUNCTION	P/R
RESOLUTION	Ratio A/B
"A" ATTENUATOR	X1
"A" DC-AC	AC
"A" LEVEL	Preset
"B" ATTENUATOR	X1
"B" DC-AC	AC
"B" LEVEL	Preset
SEP-COM	Sep
SLOW-FAST	Slow
RECYCLE RATE	Full clockwise
TEST	Deactivated

b) Connect 200 MHz signal at 100 mV rms to "A" INPUT, from suitable generator.

c) Connect "B" INPUT of counter under test to T.B. SCALE OUT of the test counter. Push 100 kHz RESOLUTION button on the test counter for tests (1), (2), and (3) below. Push 100 Hz RESOLUTION button for remainder of tests. Monitor with oscilloscope.

d) Observe and record ratio of A/B by changing the inputs to "A" and "B" as follows:

TABLE 5.3 TEST #1, RATIO MEASUREMENTS

TEST #	"A" INPUT	"B" INPUT	RATIO A/B READOUT
(1)	200 MHz	100 kHz	00002000.
(2)	100 MHz	100 kHz	00001000.
(3)	50 MHz	100 kHz	00000500.
(4)	10 MHz	100 Hz	00100000.
(5)	1 MHz	100 Hz	00010000.
(6)	100 kHz	100 Hz	00001000.
(7)	10 kHz	100 Hz	00000100.
(8)	1 kHz	100 Hz	00000010.
(9)	100 Hz	100 Hz	00000001.

e) Change FUNCTION switch and test counter frequencies as indicated below. Record on data sheet.

TABLE 5.4 TEST #2,
MUTIPLE RATIO MEASUREMENTS

TEST #	"A" INPUT	"B" INPUT	FUNCTION	RATIO A/B READOUT*
(1)	200 MHz	100 kHz	Per-Ratio X10	0002000.0
(2)	100 MHz	100 kHz	Per-Ratio $X10^2$	001000.00
(3)	50 MHz	10 kHz	Per-Ratio $X10^3$	05000.000
(4)	100 MHz	10 MHz	Per-Ratio $X10^4$	0010.0000
(5)	200 MHz	1 MHz	Per-Ratio $X10^5$	200.00000

**NOTE: Readout accuracy will be a function of signal generator resolution, stability, and trigger level accuracy.*

5.5.8 Time Interval Measurements ("B" and "C" INPUT Connectors)

1) Range: 100 ns to 10^8 seconds (10 ns to 1 second).

a) Set counter controls as follows:

FUNCTION	TIM B-C
RESOLUTION	10 ns
"B" ATTENUATOR	X1
"B" DC-AC	AC

"B" LEVEL	Preset
"B" SLOPE	(+)
"C" ATTENUATOR	X1
"C" DC-AC	AC
"C" LEVEL	Preset
"C" SLOPE	(+)
SEP-COM	Com
SLOW-FAST	Slow
RECYCLE RATE	Full clockwise
TEST	Deactivated

b) With a BNC "T" connector, connect output of pulse generator to "B" INPUT (Start), and oscilloscope monitor.

c) Adjust pulse generator for a 10 MHz repetition rate, 50% duty cycle, 0.3 V p-p. Gate light will be energized and display will read 000000.10 µs ±1 count. Record on data sheet.

d) Adjust pulse generator for a 5 MHz repetition rate, 50% duty cycle, 0.3 V p-p. Counter will display 000000.20 µs ±1 count. Record on data sheet.

e) Change "C" INPUT (Stop) SLOPE to minus (-). Counter will display 000000.10 µs ±1 count. Record on data sheet.

f) Change "B" INPUT (Start) SLOPE to minus(-), "C" INPUT (Stop) SLOPE to plus (+). Counter will display 000000.10 µs ±1 count. Record on data sheet.

g) Change "C" INPUT (Stop) SLOPE to minus (-). Counter will display 000000.20 µs ±1 count. Record on data sheet.

2) Sensitivity: Start and Stop, 0.3 V p-p.

a) Set counter controls as follows:

FUNCTION	TIM B-C
RESOLUTION	10 ns
"B" ATTENUATOR	X1
"B" DC-AC	AC
"B" LEVEL	Preset
"B" SLOPE	(+)
"C" ATTENUATOR	X1
"C" DC-AC	AC

"C" LEVEL	Preset
"C" SLOPE	(-)
SEP-COM	Com
SLOW-FAST	Slow
RECYCLE RATE	Full clockwise
TEST	Deactivated

b) Interconnect equipment as shown in Figure 5.1. Set test oscillator for 0.3 V p-p, 1 kHz sine wave.

c) Adjust oscilloscope for waveform shown in Figure 5.2. The intensity marker on the first graticule (positive-going) is the Start marker. The intensity marker on the second graticule is the Stop marker.

d) Decrease the oscillator output until the markers disappear. Note the peak-to-peak voltage at which the markers disappear. Record this level on the data sheet (must be $\leq$ 0.3 V p-p).

3) Trigger Level: Each channel must be continuously adjustable ±3.0 V, or more, times the attenuator factor.

a) Set counter controls as follows:

FUNCTION	TIM B-C
RESOLUTION	10 ns
"B" ATTENUATOR	X1
"B" DC-AC	AC
"B" LEVEL	Preset
"B" SLOPE	(+)
"C" ATTENUATOR	X1
"C" DC-AC	AC
"C" LEVEL	Preset
"C" SLOPE	(+)
SEP-COM	Sep
SLOW-FAST	Slow
RECYCLE RATE	Full clockwise
TEST	Deactivated

b) Interconnect equipment as shown in Figure 5.1. Set oscillator for 8 V p-p, 1 kHz sine wave.

c) Adjust oscilloscope to waveform shown in Figure 5.3.

d) Rotate the "B" LEVEL control to the maximum CW position. Marker should appear at a level of +3 volts or greater.

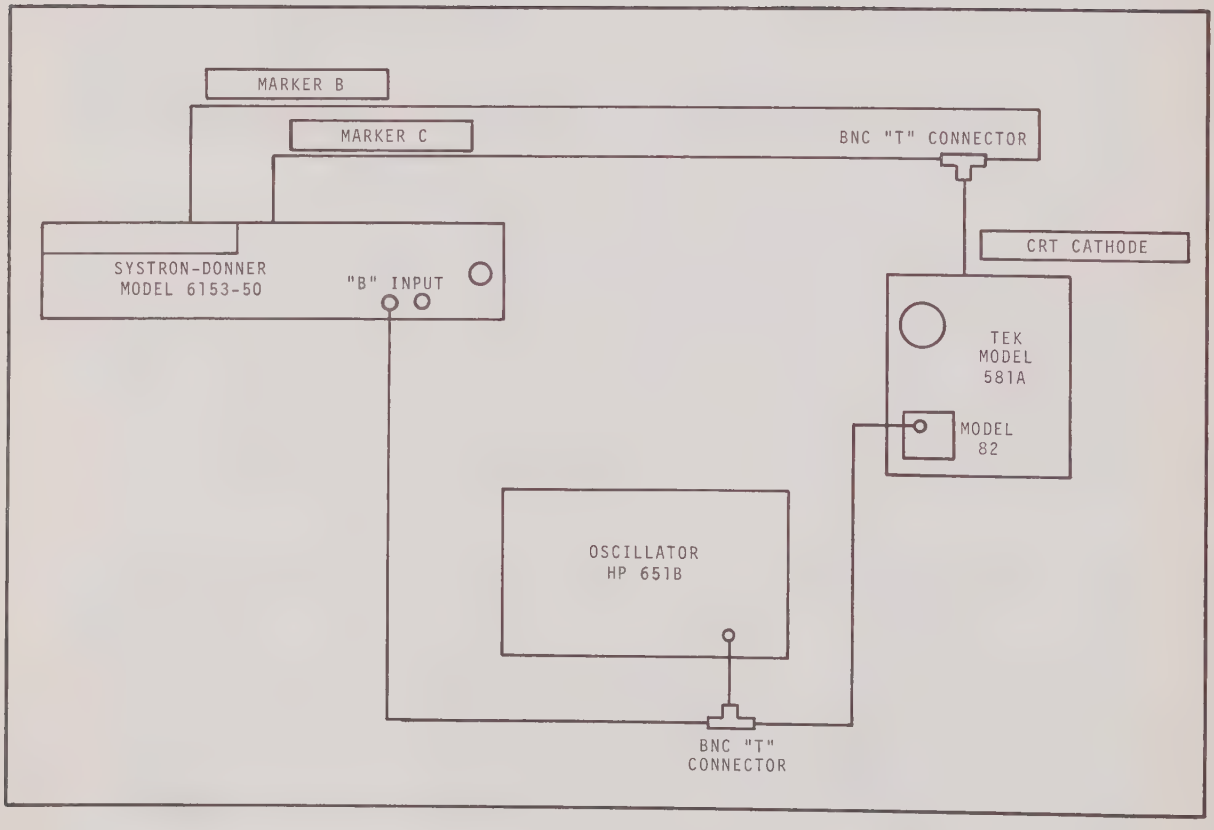
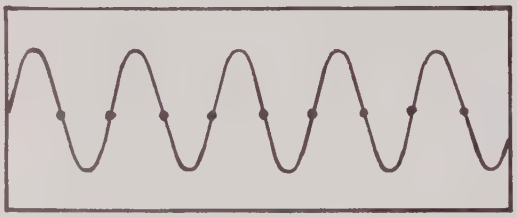
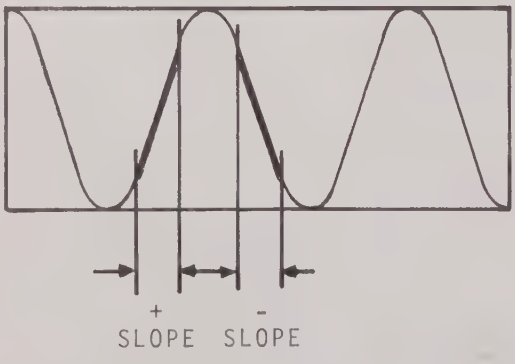


FIGURE 5.1 "B" AND "C" TRIGGER LEVEL/MARKER SENSITIVITY TEST SET UP.



OSCILLOSCOPE SETTINGS
VERTICAL: 100 mV/div.
HORIZONTAL: 0.5 ms/div.

FIGURE 5.2 "B" AND "C" MARKER INTENSITY CHECK.



OSCILLOSCOPE SETTINGS
VERTICAL: 1.0 V/div.
HORIZONTAL: 0.25 ms/div.

FIGURE 5.3 "B" AND "C" SLOPE/MARKER WAVEFORM CHECK.

e) Rotate the "B" LEVEL control to the maximum CCW position, but not into Preset. Marker should appear at a level of -3 volts or greater. Record on data sheet.

f) Change "B" SLOPE to minus (-). Repeat steps (d) and (e). Marker will now appear on negative slope of sine wave signal. Record on data sheet.

g) Remove signal from "B" INPUT and connect to "C" INPUT.

h) Repeat steps (d) through (f) and record on data sheet.

5.5.9 Time Base: (Internal Frequency)

1) Temperature Stability:

a) Connect measurement system as shown in Figure 5.4, set counter controls as follows:

Test Counter Set-Up:

FUNCTION	Rate A
RESOLUTION	.1 Hz
"A" ATTENUATOR	X10
"A" DC-AC	AC
"A" LEVEL	Preset
FAST-SLOW	Slow
RECYCLE RATE	Full clockwise
TEST	Deactivated

Oscillator Under Test:

FUNCTION	Rate A
RESOLUTION	1 MHz
RECYCLE RATE	Infinity
TEST	Deactivated

b) Place counter to be tested in a temperature-controlled environment.

c) Stabilize counter at 25° C ambient for 72 hours.

d) Calibrate the counter oscillator to the frequency standard by adjusting the coarse and fine adjust, as required, to produce a reading of 1000000.0 Hz, ±10 counts. The least significant digit represents one part in 10^{10}. Record the absolute value obtained as a reference frequency.

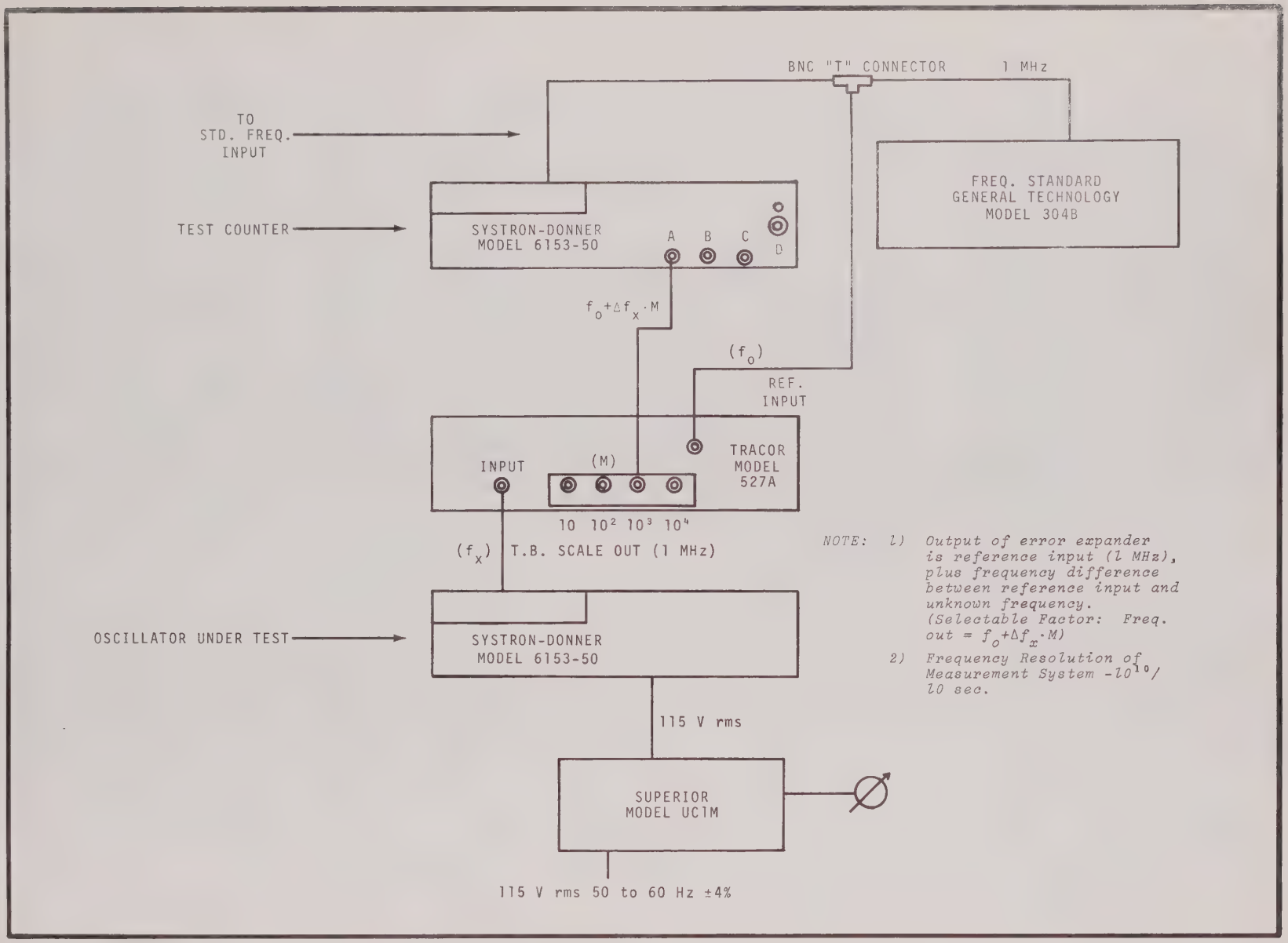


FIGURE 5.4 TIME BASE TEMPERATURE STABILITY CHECK.

e) Lower the temperature to -10° C and allow 3.5 hours to stabilize. Record observed frequency. Elevate the temperature to +50° C and allow 3.5 hours to stabilize. Record observed frequency. Lower the temperature to 25° C and allow to stabilize.

2) Line-Voltage Stability:

a) Set line voltage to counter under test,to 115 V rms with variable-voltage ac source while maintaining a stable environment. Record observed frequency. Reduce line voltage to 103 V rms and record observed frequency. Raise line voltage to 127 V rms and record observed frequency.

3) Long-Term Stability:

a) Maintain constant enviroment and line voltage. Be certain that counter has been allowed 72 hours to stabilize. Record reference frequency. Record frequency 24 hours later.

4) Time Base Output:

a) Set counter controls as follows:

FUNCTION	Rate A
RESOLUTION	As selected
RECYCLE RATE	Full clockwise
TEST	Deactivated
EXT/INT TIME BASE	INTernal
EXT/INT STD FREQ INPUT	INTernal

b) Connect oscilloscope to the T.B. SCALE OUTput; signal observed, in each instance, should be the frequency selected by the RESOLUTION switch, over the range, in decade steps, from 0.1 Hz to 10 MHz, at an amplitude of 1.0 V p-p (TTL output).

c) Connect oscilloscope to 10 MHz OUTput. Observe and record with the oscilloscope, a 10 MHz signal at an amplitude of 1.0 V p-p.

5.6 TROUBLESHOOTING PROCEDURES

1) If the instrument fails to operate, check the following items:

a) Be certain that line power is available to the instrument.

b) Check line-change switch to be sure it is in proper position for available line voltage.

c) Be sure that main power fuse is not defective.

d) Check main power switch for continuity.

e) Be certain that the power supplies are properly energized and that the output of each meets the specifications given in Section 5.11.

2) Instrument does not perform correctly in TEST.

a) Set counter to operate in accordance with procedures given in Section 3.5.

b) Use the following Tables, in sequence, to locate the defective assembly. In the indicated switch conditions; if an incorrect reading is shown, the possible defective assembly number is noted.

TABLE 5.5 TEST #1,
FREQUENCY TROUBLESHOOTING CHART

TEST ON	RESOLUTION	FUNCTION	POSSIBLE ASSEMBLY # FAILURE
Yes	1 MHz	Rate A	A12,A11,A10,A1,A4,A3,A2,U1
Yes	100 kHz	Rate A	A10,A1
Yes	10 kHz	Rate A	A10,A1
Yes	1 kHz	Rate A	A10,A1
Yes	100 Hz	Rate A	A10,A1
Yes	10 Hz	Rate A	A10,A1
Yes	1 Hz	Rate A	A10,A1
Yes	0.1 Hz	Rate A	A10,A1
Yes	1 MHz	Rate D	A14,A11,A12

TABLE 5.6 TEST #2,
PERIOD TROUBLESHOOTING CHART

TEST ON	RESOLUTION	FUNCTION	POSSIBLE ASSEMBLY # FAILURE
Yes	10 ns	Per X1	A11,A12,A10
Yes	10 ns	Per X10	A10
Yes	10 ns	Per $X10^2$	A10
Yes	10 ns	Per $X10^3$	A10
Yes	10 ns	Per $X10^4$	A10
Yes	10 ns	Per $X10^5$	A10

c) If trouble occurs during operation in the Rate A function, check assembly A16.

d) If trouble occurs during operation in the TIM function, check assemblies A18, A19.

e) If trouble occurs during operation in the Rate D function, check assemblies A20, A15, and A14.

f) If the high stability oscillator does not calibrate correctly, check assemblies A2, A3, and nonrepairable oscillator assembly U1.

g) If trouble occurs with decimal operation, check assembly A8.

h) If trouble occurs with the measurement unit annunciator, check assembly A9.

i) If trouble occurs with BCD output operation, check assemblies A1, A11, A12, and A1A2.

5.7 INSTRUMENT COVER REMOVAL

1) Top cover - Remove the two flush-mounted screws which are exposed on the top cover. Slide the cover to the rear and lift upwards.

2) Bottom cover - Remove the two flush-mounted screws which are located toward the two edges of the cover. Slide the cover to the rear and lift upwards.

5.8 ASSEMBLY LOCATION

Modular assemblies and major components are shown in Assembly Drawing 39641.

5.9 PRINTED CIRCUIT BOARD REMOVAL

1) A1 Readout: Disconnect the two cables from the assembly, remove the two screws securing BCD output assembly A1A2, and unplug from assembly A1. Remove the screws holding assembly A1 in place and lift the board upwards and toward the rear of the instrument.

2) A20 Mixer: Unplug the cable from assembly A15. Remove the two screws located on the front panel above and below the Rate "D" INPUT connector. The assembly will move to the rear and upward for removal.

3) All other board assemblies are removed directly upward after first actuating the board lifters.

5.10 PRINTED CIRCUIT BOARD REPAIR

When replacing integrated circuits or other electronic components soldered to printed-circuit boards, the procedures indicated below must be followed or damage to the board may result:

1) Determine by troubleshooting techniques, which integrated circuit or discrete component(s) has failed.

2) Remove the defective component(s) from the board by cutting the pins or leads with a small diagonal clipping tool. (Always remove and replace the entire component.)

3) Apply heat (40-50 W soldering iron) sparingly to each of the cut pins or leads and remove from the board; clean the hole(s) with a toothpick or solder suction tool.

4) Form the tinned leads of the replacement part and insert in the printed circuit holes; solder, then trim leads to extend 1/16-inch beyond the back surface of the board. (Use only 63-37 solder with maximum 1/16-inch diameter.)

CAUTION

Always trim semiconductor leads only after soldered installation is complete. This procedure greatly lessens the possibility of component failure due to shock-wave damage caused by the trimming tool.

5) When soldering semiconductor devices and all small components, be sure to use a heat sink tool or long-nosed plier connected to the component lead(s) while each is being soldered. Allow the soldered connection to cool before removing the heat sink.

6) Clean all dirt and solder-flux from the printed circuit traces by liberal application of isopropyl alcohol or freon-type solvents.

5.11 CIRCUIT ADJUSTMENTS

Adjustments to instrument circuits must be made in the order shown; however, these should not be made unless a trouble has been found which definitely indicates the need for such an adjustment(s). All voltages, unless noted, are referenced to the chassis.

1) Main Power - Assembly A13 (Set line voltage to 115 V or 230 V ac.)

   a) Measure voltage on positive lug of capacitor C3 and read +225, ±20 V. No adjustment is available, however, this voltage must be checked.

   b) Measure +12.0, ±0.1 V at the +12 V Test Point on assembly A13. If the voltage is in error, adjust +12 V adj control on the same board.

   c) Measure -12.0, ±0.1 V at the -12 V Test Point on assembly A13. If voltage is in error adjust -12 V adj control on the same board.

   d) Measure +5.00, ±0.05 V at the +5 V Test Point on assembly A13. If the voltage is in error adjust the +5 V adj control on the same board.

e) Measure -5.20, ±0.05 V at the -5.2 V Test Point on assembly A13. If the voltage is in error adjust the -5.2 V adj control on the same board.

2) 3 MHz Oscillator Power - Assembly A2 (Instrument should be "on" at least 15 minutes)

a) Measure +28.0, ±2.0 V at A2 (E).

3) 10 MHz Oscillator - Assembly A3 (ambient temperature 25° C ±5° C)

a) Set the EXTernal/INTernal STD FREQ INPUT switch to EXTernal. DO NOT inject an external frequency.

b) Connect A3 (TP1) to ground.

c) Synchronize the oscilloscope to an external frequency standard. Connect the 10 MHz output of the counter under test to the vertical amplifier of the oscilloscope.

d) Adjust A3 C2 for a stable trace on the oscilloscope.

e) Remove ground from A3 (TP1) and adjust A3 R23 for stable trace on oscilloscope.

f) Return instrument to normal operation.

4) 100 MHz Multiplier - Assembly A4

a) Measure with oscilloscope at A4 (22); check for a 100 MHz signal with $\geq$1 V p-p amplitude. If frequency or voltage is out of specification, proceed to steps b) through d).

b) Check A4 (3) for a 10 MHz signal with an amplitude between 2 V and 5 V p-p.

c) Observe A4 (22); adjust A2 C11, A2 C12, A2 C15, and A2 C16 until a maximum-amplitude 100 MHz signal is obtained.

NOTE: If A2 C10 and A2 C12 are badly misadjusted, an improper 60 MHz signal may be obtained.

d) Repeat step c) until maximum amplitude is obtained, taking care that A2 C16 is the last adjustment in the sequence.

5) 10 MHz Amplifier - Assemblies A18 and A19 (LEVEL in Preset, ATTENUATOR X1, SEP-COM switch to COM.)

a) Connect test oscillator to "B" INPUT. Adjust output of oscillator for 100 mV rms, at 100 kHz.

b) Connect "B" MARKER output J9 to input of oscilloscope.

c) Observe "B" MARKER output while reducing oscillator input signal level and adjust A18 R7 for best sensitivity.

d) Connect "C" MARKER output J10 to input of oscilloscope.

e) Observe "C" MARKER output while reducing oscillator input signal level and adjust A19 R7 for best sensitivity.

6) 200 MHz Amplifier - Assembly A16 (LEVEL in Preset, ATTENUATOR X1)

a) With voltmeter, balance the differential pair Q1A and B and Q3-Q4 by adjusting R9. Balance should be within 20 millivolts. Measure balance at R29 and R32.

b) Connect test oscillator to "A" INPUT. Adjust R13 to provide best sensitivity at 200 MHz when in the COUNT A mode.

c) Disconnect input signal and confirm balance at R29 and R32. Readjust R9 and repeat (b).

7) Mixer - Assembly A20

a) Turn FUNCTION switch to RATE D and RESOLUTION switch to 10 kHz (no connection to "D" INPUT).

b) Adjust A20 R17 for ±0.00 V at lug A20-C, the output of U1.

c) Observe A15 TP1 for symmetrical sawtooth waveform. Adjust A15 R55 to mid-position.

d) Connect a 3.0 GHz signal to the "D" INPUT. Set the input level to -15 dBm. Measure the junction of A20 R36 and A20 R19, and set the reading on this junction to -1.75 V with A20 R19.

e) Adjust A15 R55 to provide correct frequency indication with the least clockwise rotation (minimum gain).

5.12 CALIBRATION

The 3 MHz oscillator is the only component in the instrument requiring routine calibration in order to maintain best accuracy and performance. A periodic check-out/adjustment of oscillator frequency is a necessary requirement for normal operation, and especially when high accuracy is demanded. When calibration is required, be sure that the instrument has been "on" and operating for 72 hours continuously.

a) Connect the test frequency standard (traceable to N.B.S.) to the external trigger input of the oscilloscope. Connect the 10 MHz OUTput J7 to the input of the oscilloscope. Set the horizontal sweep rate to 10 ns/cm.

b) Set the fine/coarse frequency adjust on the oscillator, as required, to produce a stationary waveform.

c) If the waveform moves at a rate of 1 centimeter per second, the two frequencies are within ±1 part in 10^8 of each other. A rate of 1 centimeter per 10 second period indicates that the two frequencies are within ±1 part in 10^9 of each other.

TABLE 5-7
PERFORMANCE DATA SHEET

Systron-Donner Model 6153-50
Serial Number _____

Date of Test: _____
Test Performed By: _____

Reference Paragraph	TEST OPERATION		ACTUAL PERFORMANCE CHECK	
	Frequency Measurements			
5.5.1	**Rate A Measurements**			
	DC-Coupled 0-200 MHz		_____	0-200 MHz
	AC-Coupled 10 Hz-200 MHz		_____	10 Hz-200 MHz
	Pulse 300 mV p-p		_____	300 mV p-p
	Pulse 1.0 V p-p		_____	1.0 V p-p
5.5.2	**Rate D Measurements**			
	200 MHz to 3 GHz		_____	200 MHz to 3 GHz
		RESOLUTION SWITCH POSITION		
5.5.3	**Frequency Resolution**			
	From 1 MHz to 0.1 Hz	1 MHz	_____	00000010 MHz
		100 kHz	_____	0000010.0 MHz
		10 kHz	_____	000010.00 MHz
	NOTE: All readings ±1 count.	1 kHz	_____	00010000 kHz
		100 Hz	_____	0010000.0 kHz
		10 Hz	_____	010000.00 kHz
		1 Hz	_____	10000.000 kHz
		0.1 Hz	_____	(1)0000.0000 kHz

TABLE 5-7 (Cont'd)
PERFORMANCE DATA SHEET

	TEST OPERATION		ACTUAL PERFORMANCE CHECK	
		RESOLUTION SWITCH POSITION		
5.5.4	Test - Rate A			
	Counts 100 MHz	1 MHz	_____	00000100 MHz
		100 kHz	_____	0000100.0 MHz
		10 kHz	_____	000100.00 MHz
		1 kHz	_____	00100000 kHz
		100 Hz	_____	0100000.0 kHz
		10 Hz	_____	100000.00 kHz
		1 Hz	_____	(1)00000.000 kHz
		0.1 Hz	_____	(1)(0)0000.0000 kHz
5.5.5	Scaling Measurements	SCALE FACTOR		
	"A" Input Frequency 150 MHz	10	_____	15 MHz
		10^2	_____	1.5 MHz
		10^3	_____	150 kHz
		10^4	_____	15 kHz
		10^5	_____	1.5 kHz
		10^6	_____	150 Hz
		10^7	_____	15 Hz
		10^8	_____	1.5 Hz
		10^9	_____	.15 Hz

5.5.6 Period and Multiple Period Measurements

1) Frequency input 10 MHz; RESOLUTION switch to 10 ns.

2) Change FUNCTION switch as shown:

TABLE 5-7 (Cont'd)
PERFORMANCE DATA SHEET

	TEST OPERATION		ACTUAL PERFORMANCE CHECK	
5.5.6	Period and Multiple Period Measurements (Cont'd)			
		FUNCTION SWITCH POSITION		
	NOTE: Accuracy depends on ± trigger error, ±1 count, ±frequency difference of oscillators.	Period X1	_____	000000.10 µs
		Period X10	_____	00000.100 µs
		Period X10^2	_____	0000.1000 µs
		Period X10^3	_____	000.10000 µs
		Period X10^4	_____	00.100000 µs
		Period X10^5	_____	0.1000000 µs

3) Frequency input 1 Hz; FUNCTION switch, Period X1.

4) Change RESOLUTION switches as shown:

		RESOLUTION SWITCH POSITION		
	NOTE: Accuracy depends on ± trigger error, ±1 count, ± frequency difference of oscillators.	10 ns	_____	(1)000000.00µs
		100 ns	_____	1000000.0 µs
		1 ns	_____	01000000 µs
		10 µs	_____	001000.00 ms
		100 µs	_____	0001000.0 ms
		1 ms	_____	00001000 ms
		10 ms	_____	000001.00 s
		100 ms	_____	0000001.0 s
		1 s	_____	00000001(.) s
		10 s	*	*

TABLE 5-7 (Cont'd)
PERFORMANCE DATA SHEET

	TEST OPERATION	ACTUAL PERFORMANCE CHECK

5.5.7 Ratio and Multiple Ratio Measurements

1) FUNCTION switch to Ratio X1.

2) RESOLUTION switch to Ratio A/B.

3) Frequency inputs to "A" and "B" as follows:

NOTE: Accuracy depends on ± trigger level, ±1 count, ± frequency difference of oscillators.

"A" INPUT	"B" INPUT		
200 MHz	100 kHz	_____	00002000
100 MHz	100 kHz	_____	00001000
50 MHz	100 kHz	_____	00000500
10 MHz	100 Hz	_____	00100000
1 MHz	100 Hz	_____	00010000
100 kHz	100 Hz	_____	00001000
10 kHz	100 Hz	_____	00000100
1 kHz	100 Hz	_____	00000010
100 Hz	100 Hz	_____	00000001

4) Change FUNCTION switch, "A" and "B" Input as follows:

"A" INPUT	"B" INPUT	FUNCTION SWITCH		
200 MHz	100 kHz	Ratio X10	_____	0002000.0
100 MHz	100 kHz	Ratio $X10^2$	_____	001000.00
50 MHz	10 kHz	Ratio $X10^3$	_____	05000.000
100 MHz	10 MHz	Ratio $X10^4$	_____	0010.0000
200 MHz	1 MHz	Ratio $X10^5$	_____	200.00000

TABLE 5-7 (Cont'd)
PERFORMANCE DATA SHEET

	TEST OPERATION			ACTURAL PERFORMANCE CHECK	
5.5.8	Time Interval Measurements			*NOTE: All reading allowed ±1 count error.*	
	1) Range: 100 ns to 10^8 seconds.				
	START "B" SLOPE	STOP "C" SLOPE	COM INPUT "B" & "C"		
	+	+	10 MHz	_____	000000.10 µs
	+	+	5 MHz	_____	000000.20 µs
	+	-	5 MHz	_____	000000.10 µs
	-	+	5 MHz	_____	000000.10 µs
	-	-	5 MHz	_____	000000.20 µs
	2) Sensitivity:				
	Both markers disappear at:			_____	≤0.3 V p-p
	3) Trigger Level: ±3.0 V X attenuation factor				
	"B" INPUT	Start +	Level CW	_____	≥ +3.0 V
		Start +	Level CCW	_____	≥ -3.0 V
		Start -	Level CW	_____	≥ +3.0 V
		Start -	Level CCW	_____	≥ -3.0 V
	"C" INPUT	Stop +	Level CW	_____	≥ +3.0 V
		Stop +	Level CCW	_____	≥ -3.0 V
		Stop -	Level CW	_____	≥ +3.0 V
		Stop -	Level CCW	_____	≥ -3.0 V
5.5.9	Time Base				
	1) Temperature Stability (±2 X 10^{10}/°C from -10°C to +50°C):				
	Reference frequency			_____	1000000.0 ±10
	-10°C frequency			_____	Reference ±70 counts
	+50°C frequency			_____	Reference ±50 counts

TABLE 5-7 (Cont'd)
PERFORMANCE DATA SHEET

	TEST OPERATION	ACTUAL PERFORMANCE CHECK	
5.5.9	Time Base (Cont'd)		
	2) Line Voltage ($\pm 5 \times 10^{10}$ for a ±10% line change):		
	Reference frequency	_____	
	-10% line (103 V ac)	_____	Reference ±5 counts
	+10% line (127 V ac)	_____	Reference ±5 counts
	3) Long-term stability ($\pm 3 \times 10^{9}$/24 hours):		
	Reference frequency	_____	
	24 hours later	_____	Reference ±30 counts
	4) Time Base Output (1.0 V p-p from 10 MHz to 0.1 Hz):		
	RESOLUTION SWITCH POSITION		
	100 ns	_____	10 MHz, ≥1.0 V p-p
	1 MHz	_____	1 MHz ≥1.0 V p-p
	100 kHz	_____	100 kHz, ≥1.0 V p-p
	10 kHz	_____	10 kHz, ≥1.0 V p-p
	1 kHz	_____	1 kHz, ≥1.0 V p-p
	100 Hz	_____	100 Hz, ≥1.0 V p-p
	10 Hz	_____	10 Hz, ≥1.0 V p-p
	1 Hz	_____	1 Hz, ≥1.0 V p-p
	0.1 Hz	_____	0.1 Hz, ≥1.0 V p-p
	5) 10 MHz Output:		
		_____	10 MHz, ≥1.0 V p-p

CHAPTER 6

FINAL ASSEMBLY PARTS LIST

REF.	DESCRIPTION	SD PART NO.	QTY.
	Model 6153-50 Block Diagram	F39384	
10	Test Assembly	D39641	1
12	Bottom Cover Assembly	C39644	1
14	Top Cover	D33760-4	1
16	Side Cover	C33764-4	2
18	End Trim	C33693	4
20	Side Trim	C33564-4	2
22	Handle	C33570-4	2
24	Side Trim, Top	39859-4	2
26	Nut, Tinnerman	H1907	4
28	Connector w/Hood, 50 Pin	J0170	1
21	Mother Board P.C. Assembly	39114	1
22	Rear Panel Assembly	D39187	1
23	Front Panel Assembly	D39188	1
24	Power Supply Chassis Assembly	D39189	1
U1	3 MHz Oscillator Assembly	B33428	1
A1A1	Annunciator Assembly	C39186	1
A1A2	BCD Output P.C. Assembly	B39379	1
A1	Readout P.C. Assembly	C39383	1
A2	3 MHz Oscillator Power P.C. Assembly	B39367	1
A3	10 MHz Oscillator P.C. Assembly	B39359	1
A4	100 MHz Mult. P.C. Assembly	B39363	1
A6	Attenuator Select P.C. Assembly	B39355	1
A7	Function Select P.C. Assembly	B39803	1
A8	Legend Logic P.C. Assembly	B39335	1
A9	Decimal Logic P.C. Assembly	C39339	1
A10	Time Base P.C. Assembly	C38347	1
A11	Function Control P.C. Assembly	C39343	1
A12	200 MHz Decade & Gate P.C. Assembly	C39327	1
A13	Main Power P.C. Assembly	B39351	1
A14	"N" Computer P.C. Assembly	B39375	1
A15	Shifter P.C. Assembly	C39371	1
A16	200 MHz Amplifier P.C. Assembly	B39323	1
A18,A19	10 MHz Amplifier P.C. Assembly	B39331	2
A20	Mixer Cable Assembly	B39784	1
46	Extender P.C. Assembly	B39153	1
	Front Panel Assembly	D39188	
1	Decorative Panel	D39402-1	1
2	Sub-panel	D39413	1
3	Polarized Window	B39392	1
4	Front Trim	C33762	2
5	Trim Strip	B39394	1

FINAL ASSEMBLY PARTS LIST (Cont'd)

REF.	DESCRIPTION	SD PART NO.	QTY.
S2	Switch, Rotary	A39655	1
S22	Switch, Toggle w/Black Decorative Nut	S0397	1
S3	Switch, Pushbutton N.O.	S0398	1
S10,S12, S13,S15, S16,S17, S18	Switch, Slide, SPDT	05034990	7
R9-S4	Switch & Potentiometer, SPST, 2 M	R2702	1
R1-S5, R2-S6, R3-S7	Switch & Potentiometer, SPDT, 5 k	R2077	3
S9,S11, S14	Switch, Slide, DPTT	S0399	3
J1,J2, J3	Connector, BNC	J0260	3
24	Knob, Bar (Not Shown)	H1965	1
25	Knob, Round (Not Shown)	H1964	4
26	Front Panel Cable Assembly	D39779	1
	Rear Panel Assembly	D39187	
1	Rear Panel	D39314	1
2	Cover Plate, Mixer	A39442	1
3	Cover Plate, 36 Pin	A38621	1
4	Cover Plate, 50 Pin	A39443-2	1
5	Filter Assembly, AC Line	A31331-4-1	1
6	Plate, Fan Mounting	B39614	1
B1	Fan	H1786	1
S21	Slide Switch, DPDT	S0384	1
S8,S20, S23	Slide Switch, SPDT	05034990	3
10	Fuse Holder	X0034	2
11	Snap Button	H1667	3
J5-J10, J13	Connector, BNC	J0165	7
F2	Fuse, 1/4 A, Slo-Blo	F0067	1
F1	Fuse, 1 A, Slo-Blo	F0005	1
28	Nameplate	A23456	
	Bottom Cover Assembly	C39644	
1	Bottom Cover	D39643	1
2	Bail & Foot Assembly	H1813	1

FINAL ASSEMBLY PARTS LIST (Cont'd)

REF.	DESCRIPTION	SD PART NO.	QTY.
	Test Assembly	D39641	
1	Cage, Left Side	C39155	1
2	Cage, Center Divider	C39387	1
3	Cage, Front Plate	C39154	1
4	Cage, Right Side	C39386	1
5	Cage, Center Plate	B39389	1
6	Cage, Runner	B39390	4
7	Side Support	B39388	1
8	Gusset, Left	C39436	1
9	Gusset, Right	C39437	1
12	P.C. Guide, Nylon	A21340-1-1	18
13	P.C. Guide, Nylon, Modified	A39567	2
14	P.C. Guide (Birtcher Clip)	H1826	1
16	Caterpiller Strip	H1829	A/R
	Power Supply Chassis Assembly	D39189	
1	Chassis, Power Supply	D39315	1
2	Transistor Bracket Assembly	A39624	1
T1	Transformer	C39573	1
T2	Transformer	B19805	1
Q1,Q2, Q3	Transistor, 2N5190	Q0281	3
Q4,Q5	Transistor, 2N5193	Q0300	2
C2,C3	Capacitor, 1100 µF, 25 V	03287050	2
C1	Capacitor, 20 µF, 450 V	C1150	1
C9	Capacitor, 500 µF, 50 V	03286060	1
CR1,CR2	Diode, MR1120R	CR0337	2
12	Capacitor, MTG, Wafer	H0488	1
14	Grommet, Heyco, SB250-2	H0883	1
15	Grommet, Heyco, SB375-4	H1244	1
	Mother Board P.C. Assembly	C39114	
9	Cage, Right Side	C39386	1
10	Cage, Center Divider	C39387	1
11	Side Support	B39388	1
12	Cage, Center Plate	B39389	1
13	Cage, Runner	B39390	4
14	Cage, Front Plate	C39154	1
15	Cage, Left Side	C39155	1
16	Modification, P.C. Guide	A39567	2
C4,C5, C6	Capacitor, 4600 µF, 12 V	C1112	3
C10,C11, C12,C13	Capacitor, 4.7 µF, 35 V	C0406	4

FINAL ASSEMBLY PARTS LIST (Cont'd)

REF.	DESCRIPTION	SD PART NO.	QTY.
C14	Capacitor, 27 pF, Chip	C1250	1
C15	Capacitor, .001 µF, 1 kV	C0235	1
C16	Capacitor, .1 µF, 600 V	03285090	1
C17	Capacitor, .8-4.5 pF	03270220	1
C18,C19	Capacitor, 22 pF, Chip	C1177	2
C20	Capacitor, 220 pF, Chip	C1251	
CR3,CR4, CR5	Diode, 1N4151	CR0150	3
K1,K2	Relay, Reed, Form A, 1 kV	K0132	2
L3	Inductor, .06 µH	L0158	
L4	Coil Reed Switch	L0169	1
R4	Resistor, 22 Ω, 1/4 W, 5%	R1436	1
R5	Resistor, 100 Ω, 1/4 W, 5%	R0966	1
R6	Not Used		
R7	Resistor, 910 k, 1/4 W, 5%	R2312	1
R8	Resistor, 200 k, 1/4 W, 5%	R0823	1
R9	Resistor, 20 k, 1/4 W, 5%	R0964	1
R10	Resistor, 180 k, 1/4 W, 5%	R1042	1
R13	Resistor, 47 Ω, 1/4 W, 5%	R0743	
S1	Switch, Pushbutton, 12 Sta.	S0409	1
S19	Switch, Reed, H.V.	A37288	1
XA2-XA4, XA6-XA16, XA18,XA19	Connector, 50 Pin P.C.	J0606	16
35	Grommet, Caterpillar	38023720	A/R
	Mixer Cable Assembly	B39784	
1	Mixer Assembly	C33351	1
P18	Connector	J0605	1
	Transistor Bracket Assembly	A39624	
1	Transistor Mtg. Bracket	B39438	1
2	Transistor Socket	X0187	5
3	Transistor Socket Retainer	H1966	5
A1A1	Annunciator Assembly	C39186	
1	Annunciator P.C. Board	B39627	1
2	Annunciator Block	C27873	1
3	Spec, Annunciator Legend Film	A39440	1
4	Amp-Modu Post Strip, 86090-4	E0322	9
5	Lamp, Incandescent (CM7220)	10101	8
7	Pressure Sensitive Tape	H1768	A/R

BCD OUTPUT P.C. ASSEMBLY PARTS LIST

REF.	DESCRIPTION	SD PART NO.
A1A2	BCD Output P.C. Assembly	B39379
	BCD Output Schematic	D39376
CR1	Diode, 1N4151	CR0150
CR2	Diode, 1N4151	CR0150
Q1	Transistor, 2N3646	Q0218
Q2	Transistor, 2N3646	Q0218
Q3	Transistor, 2N3646	Q0218
Q4	Transistor, 2N3646	Q0218
R1	Resistor, 12 k, 1/4 W, 5%	R0759
R2	Resistor, 1 k, 1/4 W, 5%	R0765
R3	Resistor, 1 k, 1/4 W, 5%	R0765
R4	Resistor, 1 k, 1/4 W, 5%	R0765
R5	Resistor, 12 k, 1/4 W, 5%	R0759
R6	Resistor, 4.7 k, 1/4 W, 5%	R0892
R7	Resistor, 4.7 k, 1/4 W, 5%	R0892
R8	Resistor, 1 k, 1/4 W, 5%	R0765
R9	Resistor, 1 k, 1/4 W, 5%	R0765
U1	Resistor Network, 4 x 5 k, 1/10 W, 20%	27867
U2	Resistor Network, 4 x 5 k, 1/10 W, 20%	27867
U3	Resistor Network, 4 x 5 k, 1/10 W, 20%	27867
U4	Resistor Network, 4 x 5 k, 1/10 W, 20%	27867
U5	Resistor Network, 4 x 5 k, 1/10 W, 20%	27867
U6	Resistor Network, 4 x 5 k, 1/10 W, 20%	27867
U7	Resistor Network, 4 x 5 k, 1/10 W, 20%	27867
U8	Resistor Network, 4 x 5 k, 1/10 W, 20%	27867
U9	Resistor Network, 4 x 5 k, 1/10 W, 20%	27867
U10	Resistor Network, 4 x 5 k, 1/10 W, 20%	27867

READOUT P.C. ASSEMBLY PARTS LIST

REF.	DESCRIPTION	SD PART NO.
A1	Readout P.C. Assembly	C39383
	Readout Schematic	E39380
C1	Capacitor, .003 µF, 500 V	C0327
C2	Capacitor, .003 µF, 500 V	C0327
C3	Capacitor, .003 µF, 500 V	C0327
C4	Capacitor, .003 µF, 500 V	C0327
C5	Capacitor, 1 µF, 35 V	C0524
C6	Capacitor, .003 µF, 500 V	C0327
C7	Capacitor, .003 µF, 500 V	C0327
C8	Capacitor, .003 µF, 500 V	C0327
C9	Not Used	
C10	Capacitor, 1 µF, 35 V	C0524
C11	Capacitor, 1 µF, 35 V	C0524
J16	Socket, 14 Pin	X0186
J17	Socket, 14 Pin	X0186
Q1	Transistor, 2N3646	Q0218
Q2	Transistor, 2N3646	Q0218
Q3	Transistor, 2N3646	Q0218
R1	Resistor, 39 k, 1/2 W, 5%	R0282
R2	Resistor, 39 k, 1/2 W, 5%	R0282
R3	Resistor, 39 k, 1/2 W, 5%	R0282
R4	Resistor, 39 k, 1/2 W, 5%	R0282
R5	Resistor, 39 k, 1/2 W, 5%	R0282
R6	Resistor, 39 k, 1/2 W, 5%	R0282
R7	Resistor, 39 k, 1/2 W, 5%	R0282
R8	Resistor, 39 k, 1/2 W, 5%	R0282
R9	Not Used	
R10	Resistor, 1 k, 1/4 W, 5%	R0765
R11	Resistor, 1 k, 1/4 W, 5%	R0765
R12	Resistor, 1 k, 1/4 W, 5%	R0765
U1	Integrated Circuit, SN74141N	25730
U2	Integrated Circuit, SN74141N	25730
U3	Integrated Circuit, SN74141N	25730
U4	Integrated Circuit, SN74141N	25730
U5	Integrated Circuit, SN74141N	25730
U6	Integrated Circuit, SN74141N	25730
U7	Integrated Circuit, SN74141N	25730
U8	Integrated Circuit, SN74141N	25730
U9	Not Used	
U10	Integrated Circuit, SN74141N	25730

P.C. ASSEMBLY PARTS LIST (Cont'd)

	DESCRIPTION	SD PART NO.
U11	Integrated Circuit, SN7475N	19710
U12	Integrated Circuit, SN7475N	19710
U13	Integrated Circuit, SN7475N	19710
U14	Integrated Circuit, SN7475N	19710
U15	Integrated Circuit, SN7475N	19710
U16	Integrated Circuit, SN7475N	19710
U17	Integrated Circuit, SN7475N	19710
U18	Integrated Circuit, SN7475N	19710
U19	Not Used	
U20	Integrated Circuit, SN74196N	25784
U21	Integrated Circuit, SN7490N	25732
U22	Integrated Circuit, SN7490N	25732
U23	Integrated Circuit, SN7490N	25732
U24	Integrated Circuit, SN7490N	25732
U25	Integrated Circuit, SN7490N	25732
U26	Integrated Circuit, SN7490N	25732
U27	Not Used	
U28	Integrated Circuit, SN74145N	25754
U29	Integrated Circuit, SN15846N	19716
U30	Integrated Circuit, SN7474N	25241
V1	Readout Tube, NL-5859S	V0131
V2	Readout Tube, NL-5859S	V0131
V3	Readout Tube, NL-5859S	V0131
V4	Readout Tube, NL-5859S	V0131
V5	Readout Tube, NL-5859S	V0131
V6	Readout Tube, NL-5859S	V0131
V7	Readout Tube, NL-5859S	V0131
V8	Readout Tube, NL-5859S	V0131
XA1	Socket, Annunciator, 10 Pin	J0608
XA2	Socket, BCD Output P.C. Assembly	J0621
XV1	Socket, Readout Tube, RTS-44	X0179
XV2	Socket, Readout Tube, RTS-44	X0179
XV3	Socket, Readout Tube, RTS-44	X0179
XV4	Socket, Readout Tube, RTS-44	X0179
XV5	Socket, Readout Tube, RTS-44	X0179
XV6	Socket, Readout Tube, RTS-44	X0179
XV7	Socket, Readout Tube, RTS-44	X0179
XV8	Socket, Readout Tube, RTS-44	X0179
XU1	Socket, IC, 8 Pin	X0185
XU2	Socket, IC, 8 Pin	X0185
XU3	Socket, IC, 8 Pin	X0185

READOUT P.C. ASSEMBLY PARTS LIST (Cont'd)

REF.	DESCRIPTION	SD PART NO.
XU4	Socket, IC, 8 Pin	X0185
XU5	Socket, IC, 8 Pin	X0185
XU6	Socket, IC, 8 Pin	X0185
XU7	Socket, IC, 8 Pin	X0185
XU8	Socket, IC, 8 Pin	X0185
XU9	Not Used	
XU10	Socket, IC, 8 Pin	X0185
XU28	Socket, IC, 8 Pin	X0185
A1A1	Annunciator Assembly	39186
A1A2	BCD Output P.C. Assembly	39379

3 MHz OSCILLATOR POWER P.C. ASSEMBLY PARTS LIST

REF.	DESCRIPTION	SD PART NO.
A2	3 MHz Oscillator Power P.C. Assembly	B39367
	3 MHz Oscillator Power Schematic	B39364
C1	Capacitor, 100 pF, 500 V, 5%	C0536
C2	Capacitor, .05 µF, 12 V	C0672
CR1	Diode, 1N4005, 600 V, 1 Amp	CR0284
CR2	Diode, 1N4005, 600 V, 1 Amp	CR0284
CR3	Diode, 1N4005, 600 V, 1 Amp	CR0284
CR4	Diode, 1N4005, 600 V, 1 Amp	CR0284
Q1	Transistor, 2N5190	Q0281
Q2	Transistor, 2N3646	Q0218
R1	Resistor, 5.6 k, 1/4 W, 5%	R0821
R2	Resistor, 27 k, 1/4 W, 5%	R0824
R3	Resistor, 20 k, 1/4 W, 5%	R0964
R4	Resistor, 6.8 k, 1/4 W, 5%	R0696
R5	Resistor, 5.6 k, 1/4 W, 5%	R0821
R6	Resistor, 1 k, 1/4 W, 5%	R0765
R7	Resistor, 1 k, 1/4 W, 5%	R0765
R8	Resistor, 5.6 k, 1/4 W, 5%	R0821
U1	Integrated Circuit, U723C	25756
U2	Integrated Circuit, 7473N	19709

10 MHz OSCILLATOR P.C. ASSEMBLY PARTS LIST

REF.	DESCRIPTION	SD PART NO.
A3	10 MHz Oscillator P.C. Assembly	B39359
	10 MHz Oscillator Schematic	C39356
C1	Capacitor, .1 µF, 200 V	C0987
C2	Capacitor, .8-18 pF, Piston	C0555
C3	Capacitor, 100 pF, 500 V	C0536
C4	Capacitor, 220 pF, 500 V	C0538
C5	Capacitor, 15 pF, 500 V	C0528
C6	Capacitor, .001 µF, 1 kV	C0235
C7	Capacitor, .001 µF, 1 kV	C0235
C8	Capacitor, .1 µF, 50 V	C0881
C9	Capacitor, .05 µF, 100 V	C0708
C10	Capacitor, 33 pF, 500 V	C0531
C11	Capacitor, 10 pF, 500 V	C0527
C12	Capacitor, .1 µF, 10 V	C0661
C13	Capacitor, .001 µF, 1 kV	C0235
C14	Capacitor, 47 pF, 500 V	C0533
C15	Capacitor, .001 µF, 1 kV	C0235
C16	Capacitor, .001 µF, 1 kV	C0235
C17	Capacitor, .01 µF, 100 V	C0556
C18	Capacitor, 680 pF, 300 V	C0638
C19	Capacitor, .1 µF, 50 V	C0881
C20	Capacitor, .01 µF, 100 V	C0556
C21	Capacitor, .02 µF, 150 V	C0322
C22	Capacitor, .05 µF, 12 V	C0672
C23	Capacitor, .05 µF, 12 V	C0672
C24	Capacitor, .01 µF, 100 V	C0556
C25	Capacitor, 150 pF, 500 V	C0537
CR1	Diode, 1N4151	CR0150
CR2	Diode, 1N4151	CR0150
CR3	Diode, MV2107	CR0375
CR4	Diode, 1N4151	CR0150
CR5	Diode, 1N4151	CR0150
CR6	Diode, 1N4151	CR0150
CR7	Diode, 1N4151	CR0150
CR8	Diode, HPA 5082-2800	CR0363
CR9	Diode, HPA 5082-2800	CR0363
VR1	Diode, Zener	CR19330
VR2	Diode, Zener	CR19330
Q1	Transistor, 2N4275	26013140
Q2	Transistor, 2N4275	26013140
Q3	Transistor, 2N4275	26013140

10 MHz OSCILLATOR P.C. ASSEMBLY PARTS LIST (Cont'd)

REF.	DESCRIPTION	SD PART NO.
R1	Resistor, 680 Ω, 1/4 W, 5%	R1234
R2	Resistor, 2.7 k, 1/4 W, 5%	R0937
R3	Resistor, 330 k, 1/4 W, 5%	R0662
R4	Resistor, 1.8 k, 1/4 W, 5%	R0959
R5	Resistor, 100 k, 1/4 W, 5%	R0741
R6	Resistor, 47 k, 1/4 W, 5%	R0771
R7	Not Used	
R8	Resistor, 100 k, 1/4 W, 5%	R0741
R9	Resistor, 4.7 k, 1/4 W, 5%	R0892
R10	Resistor, 10 k, 1/4 W, 5%	R0766
R11	Resistor, 1 k, 1/4 W, 5%	R0765
R12	Resistor, 3.3 k, 1/4 W, 5%	R0742
R13	Resistor, 1 k, 1/4 W, 5%	R0765
R14	Resistor, 2.2 M, 1/4 W, 5%	R1014
R15	Resistor, 2.7 k, 1/4 W, 5%	R0937
R16	Resistor, 2.2 M, 1/4 W, 5%	R1014
R17	Not Used	
R18	Resistor, 150 k, 1/4 W, 5%	R0961
R19	Resistor, 150 k, 1/4 W, 5%	R0961
R20	Resistor, 20 k, 1/4 W, 5%	R0964
R21	Resistor, 1.8 k, 1/4 W, 5%	R0959
R22	Resistor, 10 k, 1/4 W, 5%	R0766
R23	Resistor, 200 Ω, Potentiometer	01110240
R24	Resistor, 1.8 k, 1/4 W, 5%	R0959
R25	Resistor, 1 k, 1/4 W, 5%	R0765
R26	Resistor, 1 M, 1/4 W, 5%	R0962
R27	Resistor, 2.7 k, 1/4 W, 5%	R0937
R28	Resistor, 330 Ω, 1/4 W, 5%	R0662
R29	Resistor, 1.8 k, 1/4 W, 5%	R0959
R30	Resistor, 680 Ω, 1/4 W, 5%	R1234
T1	Transformer	A39682
TP1	Test Point, Brown	E0235
U1	Integrated Circuit, SN7400N	19705
U2	Integrated Circuit, SN7400N	19705
U3	Integrated Circuit, MC3000P	25766
U4	Integrated Circuit, LM301A	25745
U5	Integrated Circuit, MC3060	25769
Y1	Crystal, 10 MHz	A39483

100 MHz MULTIPLIER P.C. ASSEMBLY PARTS LIST

REF.	DESCRIPTION	SD PART NO.
A4	100 MHz Multiplier P.C. Assembly	B39363
	100 MHz Multiplier Schematic	C39360
C1	Capacitor, .1 µF, 50 V	C0881
C2	Capacitor, 180 pF, 500 V	C0707
C3	Capacitor, 390 pF, 500 V	C0541
C4	Capacitor, .01 µF, 50 V	C0562
C5	Capacitor, .1 µF, 50 V	C0881
C6	Capacitor, 47 pF, 500 V	C0533
C7	Capacitor, .1 µF, 50 V	C0881
C8	Capacitor, .01 µF, 50 V	C0562
C9	Capacitor, .01 µF, 50 V	C0562
C10	Capacitor, 15-60 pF	C1132
C11	Capacitor, 2 pF, 500 V	C0261
C12	Capacitor, 15-60 pF	C1132
C13	Capacitor, 180 pF, 500 V	C0707
C14	Capacitor, 470 pF, 300 V	C0542
C15	Capacitor, 5.5-18 pF	C0712
C16	Capacitor, 5.5-18 pF	C0712
C17	Capacitor, 82 pF, 500 V	C0535
C18	Capacitor, 2 pF, 500 V	C0261
C19	Capacitor, .1 µF, 50 V	C0881
L1	Inductor, .82 µH	L0059
L2	Inductor, SD B39744-1	B39744-1
L3	Inductor, SD B39744-1	B39744-1
L4	Inductor, SD B39744-2	B39744-2
L5	Inductor, SD B39744-2	B39744-2
Q1	Transistor, 2N3640	Q0178
Q2	Transistor, 2N3646	Q0218
Q3	Transistor, 2N3646	Q0218
Q4	Transistor, 2N3646	Q0218
R1	Resistor, 3.3 k, 1/4 W, 5%	R0742
R2	Resistor, 560 Ω, 1/4 W, 5%	R0819
R3	Resistor, 6.8 k, 1/4 W, 5%	R0696
R4	Resistor, 3.3 k, 1/4 W, 5%	C0742
R5	Resistor, 560 Ω, 1/4 W, 5%	R0819
R6	Resistor, 470 Ω, 1/4 W, 5%	R1044
R7	Resistor, 1 k, 1/4 W, 5%	R0765
R8	Resistor, 120 Ω, 1/4 W, 5%	R1461
R9	Resistor, 470 Ω, 1/4 W, 5%	R1044
R10	Resistor, 1 k, 1/4 W, 5%	R0765

100 MHz MULTIPLIER P.C. ASSEMBLY PARTS LIST (Cont'd)

REF.	DESCRIPTION	SD PART NO.
R11	Resistor, 470 Ω, 1/4 W, 5%	R1044
R12	Resistor, 330 Ω, 1/4 W, 5%	R0662

ATTENUATOR SELECT P.C. ASSEMBLY PARTS LIST

REF.	DESCRIPTION	SD PART NO.
A6	Attenuator Select P.C. Assembly	B39355
	Attenuator Select Schematic	B39352
R1	Resistor, 5.6 k, 1/4 W, 5%	R0821
U1	Resistor Network, 4 x 5 k, 1/10 W, 20%	27867
U2	Resistor Network, 4 x 5 k, 1/10 W, 20%	27867
U3	Resistor Network, 4 x 5 k, 1/10 W, 20%	27867
U4	Resistor Network, 4 x 5 k, 1/10 W, 20%	27867
U5	Resistor Network, 4 x 5 k, 1/10 W, 20%	27867
U6	Resistor Network, 4 x 5 k, 1/10 W, 20%	27867

FUNCTION SELECT P.C. ASSEMBLY PARTS LIST

REF.	DESCRIPTION	SD PART NO.
A7	Function Select P.C. Assembly	B39803
	Function Select Schematic	B39800
C1	Capacitor, .05 µF, 12 V	C0672
C2	Capacitor, .05 µF, 12 V	C0672
R1	Resistor, 5.6 k, 1/4 W, 5%	R0821
U1	Integrated Circuit, MC836P	25704
U2	Integrated Circuit, SN15862N	19719
U3	Resistor Network, 4 x 5 k, 1/10 W	27867
U4	Resistor Network, 4 x 5 k, 1/10 W	27867
U5	Resistor Network, 4 x 5 k, 1/10 W	27867
U6	Resistor Network, 4 x 5 k, 1/10 W	27867
U7	Resistor Network, 4 x 5 k, 1/10 W	27867
U8	Resistor Network, 4 x 5 k, 1/10 W	27867

LEGEND LOGIC P.C. ASSEMBLY PARTS LIST

REF.	DESCRIPTION	SD PART NO.
A8	Legend Logic P.C. Assembly	C39335
	Legend Logic Schematic	C39332
C1	Capacitor, .1 µF, 10 V	C0661
C2	Capacitor, .1 µF, 10 V	C0661
C3	Capacitor, .1 µF, 10 V	C0661
CR1	Diode, 1N4151	CR0150
U1	Integrated Circuit, 15846N	19716
U2	Integrated Circuit, 15846N	19716
U3	Integrated Circuit, 15846N	19716
U4	Integrated Circuit, 15846N	19716
U5	Integrated Circuit, 15846N	19716
U6	Integrated Circuit, 15846N	19716
U7	Integrated Circuit, 15862N	19719
U8	Integrated Circuit, 15862N	19719
U9	Integrated Circuit, 15830N	19712
U10	Integrated Circuit, MC836	25704
U11	Integrated Circuit, MC836	25704
U12	Integrated Circuit, MC836	25704

DECIMAL LOGIC P.C. ASSEMBLY

REF.	DESCRIPTION	SD PART NO.
A9	Decimal Logic P.C. Assembly	B39339
	Decimal Logic Schematic	C39336
C1	Capacitor, .1 µF, 10 V	C0661
C2	Capacitor, .1 µF, 10 V	C0661
C3	Capacitor, .1 µF, 10 V	C0661
U1	Integrated Circuit, MC836	25704
U2	Integrated Circuit, 15846N	19716
U3	Integrated Circuit, 15846N	19716
U4	Integrated Circuit, 15830N	19712
U5	Integrated Circuit, 15846N	19716
U6	Integrated Circuit, 15846N	19716
U7	Integrated Circuit, 15846N	19716
U8	Integrated Circuit, 15846N	19716
U9	Integrated Circuit, 15846N	19716
U10	Integrated Circuit, 15846N	19716
U11	Integrated Circuit, 15830N	19712
U12	Integrated Circuit, 15846N	19716
U13	Integrated Circuit, 15846N	19716

TIME BASE P.C. ASSEMBLY PARTS LIST

REF.	DESCRIPTION	SD PART NO.
A10	Time Base P.C. Assembly	C39347
	Time Base Schematic	C39344
C1	Capacitor, .05 µF, 12 V	C0672
C2	Capacitor, .05 µF, 12 V	C0672
C3	Capacitor, .05 µF, 12 V	C0672
C4	Capacitor, .05 µF, 12 V	C0672
C5	Capacitor, .05 µF, 12 V	C0672
C6	Capacitor, .05 µF, 12 V	C0672
C7	Capacitor, .05 µF, 12 V	C0672
C8	Capacitor, .05 µF, 12 V	C0672
R1	Resistor, 4.7 k, 1/4 W, 5%	R0892
R2	Not Used	
R3	Resistor, 470 Ω, 1/4 W, 5%	R1044
R4	Resistor, 470 Ω, 1/4 W, 5%	R1044
R5	Resistor, 330 Ω, 1/4 W, 5%	R0662
R6	Resistor, 470 Ω, 1/4 W, 5%	R1044
U1	Integrated Circuit, SN74196N	25784
U2	Integrated Circuit, SN7090N	25732
U3	Integrated Circuit, SN7090N	25732
U4	Integrated Circuit, SN7090N	25732
U5	Integrated Circuit, SN7090N	25732
U6	Integrated Circuit, SN7090N	25732
U7	Integrated Circuit, SN7090N	25732
U8	Integrated Circuit, SN7090N	25732
U9	Integrated Circuit, SN7090N	25732
U10	Integrated Circuit, SN7090N	25732
U11	Integrated Circuit, SN7090N	25732
U12	Integrated Circuit, SN7090N	25732
U13	Integrated Circuit, SN7090N	25732
U14	Integrated Circuit, SN7410N	19706
U15	Integrated Circuit, SN7454N	25772
U16	Integrated Circuit, SN7454N	25772
U17	Integrated Circuit, SN7400N	19705
U18	Integrated Circuit, SN7454N	25772
U19	Integrated Circuit, SN15846N	19716
U20	Integrated Circuit, SN7400N	19705
U21	Integrated Circuit, SN15846N	19716
U22	Integrated Circuit, SN15846N	19716

FUNCTION CONTROL P.C. ASSEMBLY PARTS LIST

REF.	DESCRIPTION	SD PART NO.
A11	Function Control P.C. Assembly	C39343
	Function Control Schematic	D39340
C1	Capacitor, .001 µF, 1000 V	C0235
C2	Capacitor, .22 µF, 35 V	C0354
C3	Capacitor, 2.2 µF, 20 V	C1009
C4	Capacitor, 4.7 µF, 35 V	C0406
C5	Capacitor, 680 pF, 500 V	C0638
C6	Capacitor, .033 µF, 35 V	C1288
C7	Not Used	
C8	Capacitor, .22 µF, 35 V	C0354
C9	Capacitor, 4.7 µF, 35 V	C0406
C10	Capacitor, .01 µF, 100 V	C0556
C11	Capacitor, 56 µF, 5 V	C1090
C12	Capacitor, 56 µF, 5 V	C1090
C13	Capacitor, .05 µF, 12 V	C0672
C14	Capacitor, .05 µF, 12 V	C0672
C15	Capacitor, .05 µF, 12 V	C0672
C16	Capacitor, .05 µF, 12 V	C0672
CR1	Diode, 1N4151	CR0150
CR2	Diode, 1N4151	CR0150
CR3	Diode, 1N4151	CR0150
CR4	Diode, 1N4151	CR0150
CR5	Diode, 1N4151	CR0150
K1	Relay, Reed, Form A, 250 V	K0133
Q1	Transistor, 2N3646	Q0218
Q2	Transistor, 2N4871	Q0266
Q3	Transistor, 2N3646	Q0218
Q4	Transistor, 2N3646	Q0218
Q5	Transistor, 2N3646	Q0218
Q6	Transistor, 2N3646	Q0218
R1	Resistor, 4.7 k, 1/4 W, 5%	R0892
R2	Resistor, 4.7 k, 1/4 W, 5%	R0892
R3	Resistor, 4.8 k, 1/4 W, 5%	R0696
R4	Resistor, 1 k, 1/4 W, 5%	R0765
R5	Resistor, 4.7 k, 1/4 W, 5%	R0892
R6	Resistor, 10 k, 1/4 W, 5%	R0766
R7	Resistor, 470 Ω, 1/4 W, 5%	R1044
R8	Resistor, 470 Ω, 1/4 W, 5%	R1044
R9	Resistor, 4.7 k, 1/4 W, 5%	R0892
R10	Resistor, 470 Ω, 1/4 W, 5%	R1044

FUNCTION CONTROL P.C. ASSEMBLY PARTS LIST (Cont'd)

REF.	DESCRIPTION	SD PART NO.
R11	Resistor, 1 k, 1/4 W, 5%	R0765
R12	Resistor, 4.7 k, 1/4 W, 5%	R0892
R13	Resistor, 12 k, 1/4 W, 5%	R0759
R14	Resistor, 3.3 k, 1/4 W, 5%	R0742
R15	Resistor, 1 k, 1/4 W, 5%	R0766
R16	Resistor, 1.5 k, 1/4 W, 5%	R0783
R17	Resistor, 470 Ω, 1/4 W, 5%	R1044
R18	Resistor, 470 Ω, 1/4 W, 5%	R1044
R19	Resistor, 2.7 k, 1/4 W, 5%	R0937
R20	Resistor, 1 k, 1/4 W, 5%	R0765
R21	Resistor, 470 Ω, 1/4 W, 5%	R1044
R22	Resistor, 470 Ω, 1/4 W, 5%	R1044
R23	Resistor, 470 Ω, 1/4 W, 5%	R1044
R24	Not Used	
R25	Resistor, 4.7 k, 1/4 W, 5%	R0892
R26	Resistor, 560 Ω, 1/4 W, 5%	R0819
R27	Resistor, 470 Ω, 1/4 W, 5%	R1044
R28	Resistor, 22 Ω, 1/4 W, 5%	R0783
U1	Integrated Circuit, SN15862N	19719
U2	Integrated Circuit, SN15846N	19716
U3	Integrated Circuit, SN15830N	19712
U4	Integrated Circuit, SN15846N	19716
U5	Integrated Circuit, SN15846N	19716
U6	Integrated Circuit, SN15862N	19719
U7	Integrated Circuit, MC1810P	25735
U8	Integrated Circuit, SN15846N	19716
U9	Integrated Circuit, SN15846N	19716
U10	Integrated Circuit, SN15846N	19716
U11	Integrated Circuit, SN15862N	19719
U12	Integrated Circuit, SN7400N	19705
U13	Integrated Circuit, SN7400N	19705
U14	Integrated Circuit, SN7400N	19705
U15	Integrated Circuit, SN7400N	19705

200 MHz DECADE & GATE P.C. ASSEMBLY PARTS LIST

REF.	DESCRIPTION	SD PART NO.
A12	200 MHz Decade & Gate P.C. Assembly	C39327
	200 MHz Decade & Gate Schematic	D39324
C1	Capacitor, 47 pF, 500 V	C0533
C2	Capacitor, 47 pF, 500 V	C0533
C3	Capacitor, 47 pF, 500 V	C0533
C4	Capacitor, 47 pF, 500 V	C0533
C5	Capacitor, 47 pF, 500 V	C0533
C6	Capacitor, 47 pF, 500 V	C0533
C7	Capacitor, .001 µF, 75 V	C1155
C8	Capacitor, .001 µF, 75 V	C1155
C9	Capacitor, .05 µF, 12 V	C0672
C10	Capacitor, .05 µF, 12 V	C0672
C11	Capacitor, .05 µF, 12 V	C0672
C12	Capacitor, .05 µF, 12 V	C0672
C13	Capacitor, .05 µF, 12 V	C0672
C14	Capacitor, .05 µF, 12 V	C0672
C15	Capacitor, .05 µF, 12 V	C0672
C16	Capacitor, 39 µF, 10 V	C0902
C17	Capacitor, .001 µF, 75 V	C1155
C18	Capacitor, .05 µF, 12 V	C0672
C19	Capacitor, .05 µF, 12 V	C0672
C20	Capacitor, .05 µF, 12 V	C0672
C21	Capacitor, .05 µF, 12 V	C0672
C22	Capacitor, 39 µF, 10 V	C0902
C23	Capacitor, .05 µF, 12 V	C0672
C24	Not Used	
C25	Capacitor, .05 µF, 12 V	C0672
C26	Capacitor, .05 µF, 12 V	C0672
C27	Capacitor, .05 µF, 12 V	C0672
C28	Capacitor, .05 µF, 12 V	C0672
C29	Capacitor, .05 µF, 12 V	C0672
C30	Capacitor, 39 µF, 10 V	C0902
CR1	Not Used	
CR2	Diode, 1N4151	CR0150
CR3	Diode, 1N4830	CR0361
CR4	Diode, 1N4151	CR0150
CR5	Diode, 1N4151	CR0150
CR6	Diode, 1N4151	CR0150
CR7	Diode, 1N4151	CR0150
CR8	Diode, 1N4151	CR0150
CR9	Diode, 1N4151	CR0150

200 MHz DECADE & GATE P.C. ASSEMBLY PARTS LIST (Cont'd)

REF.	DESCRIPTION	SD PART NO.
L1	Inductor, RF R45-4	L0143
L2	Inductor, RF R45-4	L0143
L3	Inductor, RF R45-4	L0143
Q1	Transistor, 2N3640	Q0178
Q2	Transistor, 2N3640	Q0178
Q3	Transistor, 2N3640	Q0178
Q4	Transistor, 2N3646	Q0218
Q5	Transistor, 2N3646	Q0218
R1	Resistor, 330 Ω, 1/4 W, 5%	R0662
R2	Resistor, 330 Ω, 1/8 W, 5%	R1444
R3	Resistor, 330 Ω, 1/8 W, 5%	R1444
R4	Resistor, 100 Ω, 1/8 W, 5%	R1441
R5	Resistor, 330 Ω, 1/8 W, 5%	R1444
R6	Resistor, 330 Ω, 1/8 W, 5%	R1444
R7	Resistor, 330 Ω, 1/8 W, 5%	R1444
R8	Resistor, 330 Ω, 1/8 W, 5%	R1444
R9	Resistor, 47 k, 1/4 W, 5%	R0777
R10	Resistor, 330 Ω, 1/4 W, 5%	R0662
R11	Resistor, 330 Ω, 1/8 W, 5%	R1444
R12	Resistor, 330 Ω, 1/8 W, 5%	R1444
R13	Resistor, 4.7 k, 1/8 W, 5%	R1733
R14	Resistor, 330 Ω, 1/4 W, 5%	R0662
R15	Resistor, 1 k, 1/4 W, 5%	R0765
R16	Resistor, 470 Ω, 1/4 W, 5%	R1044
R17	Resistor, 330 Ω, 1/4 W, 5%	R0662
R18	Resistor, 200 Ω, 1/4 W, 5%	R0736
R19	Resistor, 56 Ω, 1/4 W, 5%	R1554
R20	Resistor, 47 k, 1/4 W, 5%	R0777
R21	Resistor, 47 k, 1/4 W, 5%	R0777
R22	Resistor, 47 k, 1/4 W, 5%	R0777
R23	Resistor, 1 k, 1/8 W, 5%	R1453
R24	Resistor, 3.3 k, 1/8 W, 5%	R1456
R25	Resistor, 470 Ω, 1/8 W, 5%	R1451
R26	Resistor, 1 k, 1/4 W, 5%	R0765
R27	Resistor, 2.2 k, 1/4 W, 5%	R0749
R28	Resistor, 4.7 k, 1/4 W, 5%	R0892
R29	Resistor, 1 k, 1/4 W, 5%	R0765
R30	Resistor, 1 k, 1/4 W, 5%	R0765
R31	Resistor, 2.2 k, 1/4 W, 5%	R0749
R32	Resistor, 4.7 k, 1/4 W, 5%	R0892
R33	Resistor, 1 k, 1/4 W, 5%	R0765
R34	Resistor, 1 k, 1/8 W, 5%	R1453
R35	Resistor, 1 k, 1/8 W, 5%	R1453

200 MHz DECADE & GATE P.C. ASSEMBLY PARTS LIST (Cont'd)

REF.	DESCRIPTION	SD PART NO.
R36	Resistor, 47 k, 1/4 W, 5%	R0777
R37	Resistor, 1 k, 1/4 W, 5%	R0765
R38	Resistor, 510 Ω, 1/4 W, 5%	R0984
R39	Resistor, 510 Ω, 1/4 W, 5%	R0984
R40	Resistor, 510 Ω, 1/4 W, 5%	R0984
R41	Resistor, 510 Ω, 1/4 W, 5%	R0984
R42	Resistor, 510 Ω, 1/4 W, 5%	R0984
R43	Resistor, 510 Ω, 1/4 W, 5%	R0984
R44	Resistor, 270 Ω, 1/4 W, 5%	R0694
U1	Integrated Circuit, MC1662L	25778
U2	Integrated Circuit, MC1010P	25775
U3	Integrated Circuit, MC1010P	25775
U4	Integrated Circuit, MC1010P	25775
U5	Integrated Circuit, MC1023P	25718
U6	Integrated Circuit, SN7400N	19705
U7	Integrated Circuit, SN7400N	19705
U8	Integrated Circuit, MC1660L	25777
U9	Integrated Circuit, MC1011P	25776
U10	Integrated Circuit, MC1660L	25777
U11	Integrated Circuit, MC1010P	25775
U12	Integrated Circuit, MC1023P	25718
U13	Integrated Circuit, MC1670L	25765
U14	Integrated Circuit, MC1034P	25773
U15	Integrated Circuit, MC1034P	25773
U16	Integrated Circuit, MC1039P	25774
U17	Integrated Circuit, MC1039P	25774
U18	Integrated Circuit, MC1027P	25719
U19	Integrated Circuit, MC1027P	25719
U20	Integrated Circuit, MC1027P	25719
VR1	Diode, Breakdown, A39543	A39543
VR2	Diode, Breakdown, A39543	A39543
VR3	Diode, Breakdown, A39543	A39543
VR4	Diode, Breakdown, A39543	A39543
VR5	Diode, Breakdown, A39543	A39543
VR6	Diode, Breakdown, A39543	A39543
VR7	Diode, Breakdown, A39543	A39543
VR8	Diode, Breakdown, A39543	A39543
VR9	Diode, Breakdown, A39543	A39543
VR10	Diode, Breakdown, A39543	A39543

MAIN POWER P.C. ASSEMBLY PARTS LIST

REF.	DESCRIPTION	SD PART NO.
A13	Main Power P.C. Assembly	B39351
	Main Power Schematic	C39348
C1	Capacitor, 470 pF, 300 V	C0542
C2	Capacitor, 470 pF, 300 V	C0542
C3	Capacitor, 470 pF, 300 V	C0542
C4	Capacitor, 470 pF, 300 V	C0542
C5	Capacitor, .001 µF, 1000 V	C0235
C6	Capacitor, 100 µF, 25 V, Tant	C0832
CR1	Diode, 1N4005	CR0284
CR2	Diode, 1N4005	CR0284
CR3	Diode, 1N4005	CR0284
CR4	Diode, 1N4005	CR0284
CR5	Diode, 1N4005	CR0284
CR6	Diode, 1N4005	CR0284
CR7	Diode, 1N4005	CR0284
CR8	Diode, 1N4005	CR0284
CR9	Diode, 1N4719	CR0251
CR10	Diode, 1N4719	CR0251
Q1	Transistor, 2N3638	Q0181
Q2	Transistor, 2N3646	Q0218
Q3	Transistor, 2N3646	Q0218
Q4	Transistor, 2N3638	Q0181
Q5	Transistor, 2N3646	Q0218
R1	Resistor, 1.8 k, 1/4 W, 5%	R0959
R2	Resistor, 5.6 k, 1/4 W, 5%	R0821
R3	Resistor, 2 k, 1/4 W, 5%	R0734
R4	Resistor, 1 k, .2 W, 20%, Potentiometer	R2734
R5	Resistor, 3 k, 1/4 W, 5%	R0711
R6	Resistor, 1 k, 1/4 W, 5%	R0765
R7	Resistor, 1 k, 1/4 W, 5%	R0765
R8	Resistor, 500 Ω, .2 W, 20%, Potentiometer	R2733
R9	Resistor, 3 k, 1/4 W, 5%	R0711
R10	Resistor, 3 k, 1/4 W, 5%	R0711
R11	Resistor, 3 k, 1/4 W, 5%	R0711
R12	Resistor, 680 Ω, 1/4 W, 5%	R1234
R13	Resistor, 680 Ω, 1/4 W, 5%	R1234
R14	Resistor, 500 Ω, .2 W, 20%, Potentiometer	R2733
R15	Resistor, 2.2 k, 1/4 W, 5%	R0749
R16	Resistor, 680 Ω, 1/4 W, 5%	R1234
R17	Resistor, 500 Ω, .2 W, 20%, Potentiometer	R2733

MAIN POWER P.C. ASSEMBLY PARTS LIST (Cont'd)

REF.	DESCRIPTION	SD PART NO.
R18	Resistor, 2.2 k, 1/4 W, 5%	R0749
R19	Resistor, 3 k, 1/4 W, 5%	R0711
R20	Resistor, 3 k, 1/4 W, 5%	R0711
R21	Resistor, 1 k, 1/4 W, 5%	R0765
R22	Resistor, 1 k, 1/4 W, 5%	R0765
R23	Resistor, 10 k, 1/4 W, 5%	R0766
TP1	Test Point, Black	E0234
TP2	Test Point, Red	E0236
TP3	Test Point, Orange	E0237
TP4	Test Point, Yellow	E0238
TP5	Test Point, Green	E0239
U1	Integrated Circuit, U723C	25756
U2	Integrated Circuit, U723C	25756
U3	Integrated Circuit, U723C	25756
U4	Integrated Circuit, U723C	25756

N COMPUTER P.C. ASSEMBLY PARTS LIST

REF.	DESCRIPTION	SD PART NO.
A14	N Computer P.C. Assembly	B39375
	N Computer Schematic	C39372
C1	Capacitor, .1 µF, 35 V, Tant	C0806
C2	Capacitor, 1 µF, 35 V	C0524
C3	Capacitor, .05 µF, 12 V, Disc	C0672
C4	Capacitor, .05 µF, 12 V, Disc	C0672
C5	Capacitor, .05 µF, 12 V, Disc	C0672
C6	Capacitor, .05 µF, 12 V, Disc	C0672
C7	Capacitor, .05 µF, 12 V, Disc	C0672
C8	Capacitor, .05 µF, 12 V, Disc	C0672
C9	Capacitor, .05 µF, 12 V, Disc	C0672
C10	Capacitor, .05 µF, 12 V, Disc	C0672
C11	Capacitor, .05 µF, 12 V, Disc	C0902
C12	Capacitor, .05 µF, 12 V, Disc	C0672
L1	Inductor, R-45-4	L0143
R1	Resistor, 68 k, 1/4 W, 5%	R0891
R2	Resistor, 470 Ω, 1/4 W, 5%	R1044
R3	Resistor, 330 Ω, 1/4 W, 5%	R0662
R4	Resistor, 1.8 k, 1/4 W, 5%	R0959
R5	Resistor, 560 Ω, 1/4 W, 5%	R0819
R6	Not Used	
R7	Resistor, 330 Ω, 1/4 W, 5%	R0662
R8	Resistor, 1 k, 1/4 W, 5%	R0765
R9	Resistor, 330 Ω, 1/4 W, 5%	R0662
TP1	Test Point, Rt Angle, Brown	E0235
TP2	Test Point, Rt Angle, Red	E0236
U1	Integrated Circuit, SN7473N	19709
U2	Integrated Circuit, SN74193N	25763
U3	Integrated Circuit, SN74193N	25763
U4	Integrated Circuit, SN7490N	25732
U5	Integrated Circuit, SN7474N	25241
U6	Integrated Circuit, MC1670L	25765
U7	Integrated Circuit, MC1027P	25719
U8	Integrated Circuit, MC1027P	25719
U9	Integrated Circuit, MC1027P	25719
U10	Integrated Circuit, MC1662L	25778
U11	Integrated Circuit, SN7400N	19705
U12	Integrated Circuit, SN15846N	19716
U13	Integrated Circuit, MC3000	25766
U14	Integrated Circuit, SN7400N	19705
VR1	Diode, 3.3 V, 39543	A39543

SHIFTER P.C. ASSEMBLY PARTS LIST

REF.	DESCRIPTION	SD PART NO.
A15	Shifter P.C. Assembly	C39371
	Shifter Schematic	C39368
C1	Capacitor, .33 µF, 100 V	C0239
C2	Capacitor, 33 pF, 500 V	C0531
C3	Not Used	
C4	Capacitor, 1 µF, 25 V	C0879
C5	Capacitor, .05 µF, 12 V	C0672
C6	Capacitor, 33 pF, 500 V	C0531
C7	Capacitor, 10 pF, 500 V	C0527
C8	Capacitor, 1 µF, 35 V	C0524
C9	Capacitor, 10 pF, 500 V	C0527
C10	Capacitor, .01 µF, 100 V	C0556
C11	Capacitor, .001 µF, 1 kV	C0235
C12	Capacitor, .01 µF, 100 V	C0556
C13	Capacitor, .01 µF, 100 V	C0556
C14	Capacitor, 22 pF, 500 V	C0529
C15	Capacitor, 150 pF, 500 V	C0537
C16	Capacitor, 150 pF, 500 V	C0537
C17	Capacitor, 159 pF, 500 V	C1146
C18	Capacitor, .047 µF, 200 V	C0700
C19	Capacitor, 318 pF, 500 V	C1145
C20	Capacitor, 159 pF, 500 V	C1146
C21	Capacitor, 1 µF, 35 V	C0524
C22	Capacitor, .033 µF, 100 V	C0735
C23	Capacitor, 1 µF, 35 V	C0524
C24	Capacitor, .05 µF, 12 V	C0672
C25	Capacitor, .05 µF, 12 V	C0672
C26	Capacitor, 1 µF, 35 V	C0524
C27	Capacitor, .05 µF, 12 V	C0672
C28	Capacitor, .05 µF, 12 V	C0672
C29	Capacitor, .01 µF, 100 V	C0556
C30	Capacitor, 82 pF, 500 V	C0535
C31	Capacitor, .01 µF, 100 V	C0556
C32	Capacitor, .001 µF, 1 kV	C0235
C33	Capacitor, .001 µF, 1 kV	C0235
C34	Capacitor, .01 µF, 100 V	C0556
C35	Capacitor, .05 µF, 12 V	C0672
C36	Capacitor, .1 µF, 10 V	C0661
C37	Capacitor, .1 µF, 10 V	C0661
C38	Capacitor, .05 µF, 12 V	C0672
C39	Capacitor, .05 µF, 12 V	C0672
C40	Capacitor, .05 µF, 12 V	C0672

SHIFTER P.C. ASSEMBLY PARTS LIST (Cont'd)

REF.	DESCRIPTION	SD PART NO.
C41	Capacitor, .05 µF, 12 V	C0672
C42	Capacitor, .01 µF, 100 V	C0556
C43	Not Used	
C44	Not Used	
C45	Capacitor, .01 µF, 100 V	C0556
C46	Capacitor, .01 µF, 100 V	C0556
C47	Capacitor, .01 µF, 100 V	C0556
C48	Capacitor, .01 µF, 100 V	C0556
C49	Capacitor, .01 µF, 100 V	C0556
CR1	Diode, 1N4151	CR0150
CR2	Diode, 1N4151	CR0150
CR3	Not Used	
CR4	Diode, MV2108	CR0354
CR5	Diode, MV2108	CR0354
CR6	Diode, HPA2800	CR0363
CR7	Diode, 1N4151	CR0150
CR8	Diode, 1N4151	CR0150
VR1	Diode, Breakdown, 1N965B	CR0139
VR2	Diode, Breakdown, FZ902	26015850
J18	Socket, I.C., 14 Pin	X0186
L1	Inductor, 10 µH	L0153
L2	Inductor, P/O Artwork	
L3	Inductor, 2.7 µH	L0165
L4	Inductor, .05 µH	L0159
L5	Inductor, 2.7 µH	L0165
L6	Inductor, .82 µH	L0163
L7	Inductor, 2.7 µH	L0165
L8	Inductor, 2.7 µH	L0165
L9	Inductor, 2.7 µH	L0165
L10	Inductor, .82 µH	L0163
L11	Inductor, 100 µH	L0156
Q1	Transistor, 2N3646	Q0218
Q2	Transistor, 2N3646	Q0218
Q3	Transistor, 2N3565	Q0237
Q4	Transistor, 40673	Q0297
Q5	Transistor, 2N5179	Q0269
Q6	Transistor, 2N4342	Q0243
Q7	Transistor, 2N3565	Q0237
Q8	Transistor, 2N3565	Q0237
Q9	Transistor, 2N3565	Q0237

SHIFTER P.C. ASSEMBLY PARTS LIST (Cont'd)

REF.	DESCRIPTION	SD PART NO.
R1	Resistor, 4.7 k. 1/8 W, 5%	R1733
R2	Resistor, 3.3 k, 1/8 W, 5%	R1456
R3	Resistor, 22 Ω, 1/4 W, 5%	R1436
R4	Resistor, 220 k, 1/4 W, 5%	R0967
R5	Resistor, 10 k, 1/8 W, 5%	R1437
R6	Resistor, 22 k, 1/8 W, 5%	R1742
R7	Resistor, 10 k, 1/8 W, 5%	R1437
R8	Resistor, 1 k, 1/8 W, 5%	R1453
R9	Resistor, 47 k, 1/8 W, 5%	R1433
R10	Resistor, 15 k, 1/8 W, 5%	R1438
R11	Resistor, 47 k, 1/8 W, 5%	R1433
R12	Resistor, 4.7 k, 1/8 W, 5%	R1733
R13	Resistor, 100 Ω, 1/8 W, 5%	R1441
R14	Resistor, 22 k, 1/8 W, 5%	R1742
R15	Resistor, 91 k, 1/8 W, 5%	R2852
R16	Resistor, 22 k, 1/8 W, 5%	R1742
R17	Resistor, 47 k, 1/8 W, 5%	R1433
R18	Resistor, 2.2 k, 1/8 W, 5%	R1476
R19	Resistor, 220 Ω, 1/8 W, 5%	R1743
R20	Resistor, 6.8 k, 1/8 W, 5%	R1459
R21	Resistor, 4.7 k, 1/8 W, 5%	R1733
R22	Resistor, 390 Ω, 1/8 W, 5%	R1450
R23	Resistor, 15 Ω, 1/8 W, 5%	R1867
R24	Resistor, 100 Ω, 1/8 W, 5%	R1441
R25	Resistor, 15 k, 1/8 W, 5%	R1438
R26	Resistor, 1 M, 1/8 W, 1%	R2371
R27	Resistor, 12 k, 1/8 W, 5%	R2464
R28	Resistor, 499 k, 1/8 W, 1%	R2372
R29	Resistor, 1 M, 1/8 W, 1%	R2371
R30	Resistor, 3.3 k, 1/4 W, 5%	R0742
R31	Resistor, 10 k, 1/8 W, 5%	R1437
R32	Resistor, 470 Ω, 1/8 W, 5%	R1451
R33	Resistor, 5.6 k, 1/8 W, 5%	R1458
R34	Resistor, 820 Ω, 1/8 W, 5%	R2462
R35	Resistor, 4.7 k, 1/8,W, 5%	R1733
R36	Resistor, 1 k, 1/8 W, 5%	R1453
R37	Resistor, 820 Ω, 1/8 W, 5%	R2462
R38	Resistor, 1 k, 1/8 W, 5%	R1453
R39	Resistor, 220 Ω, 1/8 W, 5%	R1743
R40	Resistor, 220 Ω, 1/8 W, 5%	R1743

SHIFTER P.C. ASSEMBLY PARTS LIST (Cont'd)

REF.	DESCRIPTION	SD PART NO.
R41	Resistor, 39 Ω, 1/8 W, 5%	R1829
R42	Resistor, 560 Ω, 1/8 W, 5%	R1452
R43	Resistor, 220 Ω, 1/8 W, 5%	R1743
R44	Resistor, 220 Ω, 1/8 W, 5%	R1743
R45	Resistor, 39 Ω, 1/8 W, 5%	R1829
R46	Resistor, 560 Ω, 1/8 W, 5%	R1452
R47	Resistor, 6.8 k, 1/8 W, 5%	R1459
R48	Resistor, 6.8 k, 1/8 W, 5%	R1459
R49	Resistor, 120 Ω, 1/8 W, 5%	R2459
R50	Resistor, 120 Ω, 1/8 W, 5%	R2459
R51	Resistor, 220 Ω, 1/8 W, 5%	R1743
R52	Resistor, 220 Ω, 1/8 W, 5%	R1743
R53	Resistor, 330 Ω, 1/8 W, 5%	R1444
R54	Resistor, 2.2 k, 1/8 W, 5%	R1476
R55	Resistor, 5 k, Potentiometer	R2187
R56	Resistor, 100 Ω, 1/8 W, 5%	R1441
TP1	Test Point, Brown	E0235
U1	Integrated Circuit, LM301A	25745
U2	Integrated Circuit, CA3026	25724
U3	Integrated Circuit, CA3028A	25702

200 MHz AMP. P.C. ASSEMBLY PARTS LIST

REF.	DESCRIPTION	SD PART NO.
A16	200 MHz Amp. P.C. Assembly	B39323
	200 MHz Amp. Schematic	C39320
C1	Capacitor, .001 µF, 1 kV	C0235
C2	Capacitor, .01 µF, 100 V	C0556
C3	Capacitor, .01 µF, 100 V	C0556
C4	Capacitor, .1 µF, 10 V	C0661
C5	Capacitor, .001 µF, 75 V	C1155
C6	Capacitor, .1 µF, 10 V	C0661
C7	Capacitor, .1 µF, 10 V	C0661
C8	Capacitor, .01 µF, 100 V	C0556
C9	Capacitor, .01 µF, 100 V	C0556
C10	Capacitor, .01 µF, 100 V	C0556
C11	Capacitor, .001 µF, 75 V	C1155
C12	Capacitor, .01 µF, 100 V	C0556
C13	Capacitor, 15 pF, 500 V	C0528
C14	Not Used	
C15	Capacitor, .001 µF, 1 kV	C0235
CR1	Diode, 1N4151	CR0150
CR2	Diode, 1N4151	CR0150
CR3	Diode, 1N4151	CR0150
CR4	Diode, 1N4151	CR0150
CR5	Diode, 1N4151	CR0150
CR6	Not Used	
CR7	Not Used	
CR8	Diode, 1N4151	CR0150
L1	Coil, Reed	L0169
L2	Coil, Reed	L0174
L3	Coil, Reed	L0174
L4	Inductor, 270 µH	L0067
L5	Inductor, R.F., R45-4	L0143
L6	Inductor, .06 µH	L0158
Q1	Transistor, SD A39843	A39843
Q2	Transistor, 2N2907	Q0174
Q3	Transistor, MM4049	Q0303
Q4	Transistor, MM4049	Q0303
Q5	Transistor, 2N5179	Q0269
Q6	Transistor, 2N5179	Q0269
Q7	Transistor, 2N5179	Q0269
Q8	Transistor, 2N3640	Q0178
Q9	Transistor, 2N4959	Q0274
Q10	Transistor, 2N4959	Q0274

200 MHz AMP. P.C. ASSEMBLY PARTS LIST (Cont'd)

REF.	DESCRIPTION	SD PART NO.
R1	Resistor, 100 k, 1/2 W, 5%	R0352
R2	Resistor, 390 Ω, 1/4 W, 5%	R0880
R3	Resistor, 330 Ω, 1/8 W, 5%	R1444
R4	Resistor, 100 Ω, 1/4 W, 5%	R0966
R5	Resistor, 100 Ω, 1/4 W, 5%	R0966
R6	Resistor, 390 Ω, 1/4 W, 5%	R0880
R7	Resistor, 560 Ω, 1/4 W, 5%	R0819
R8	Resistor, 2.2 k, 1/4 W, 5%	R0749
R9	Resistor, 200 Ω, Potentiometer	R2705
R10	Resistor, 560 Ω, 1/4 W, 5%	R0819
R11	Resistor, 330 Ω, 1/8 W, 5%	R1444
R12	Resistor, 270 Ω, 1/4 W, 5%	R0694
R13	Resistor, 2 k, Potentiometer	R2704
R14	Resistor, 2.2 k, 1/8 W, 5%	R1476
R15	Resistor, 2.7 k, 1/8 W, 5%	R1749
R16	Resistor, 220 Ω, 1/8 W, 5%	R2732
R17	Resistor, 1 M, 1/4 W, 5%	R0962
R18	Not Used	
R19	Resistor, 56 Ω, 1/4 W, 5%	R1554
R20	Resistor, 100 Ω, 1/4 W, 5%	R0966
R21	Resistor, 820 Ω, 1/4 W, 5%	R0762
R22	Resistor, 390 Ω, 1/4 W, 5%	R0880
R23	Resistor, 100 Ω, 1/4 W, 5%	R0966
R24	Resistor, 390 Ω, 1/4 W, 5%	R0880
R25	Resistor, 2.2 k, 1/4 W, 5%	R0749
R26	Resistor, 390 Ω, 1/4 W, 5%	R0880
R27	Resistor, 47 Ω, 1/4 W, 5%	R0743
R28	Resistor, 1 k, 1/4 W, 5%	R0765
R29	Resistor, 220 Ω, 1/4 W, 5%	R0760
R30	Resistor, 620 Ω, 1/8 W, 5%	02395630
R31	Resistor, 620 Ω, 1/4 W, 5%	R1334
R32	Resistor, 220 Ω, 1/8 W, 5%	R1743
R33	Resistor, 4.7 k, 1/4 W, 5%	R0892
R34	Resistor, 4.7 k, 1/4 W, 5%	R0892
R35	Resistor, 560 Ω, 1/4 W, 5%	R0819
R36	Resistor, 560 Ω, 1/4 W, 5%	R0819
S1	Switch, Reed	A37288
S2	Switch, Reed	S0400
S3	Switch, Reed	S0400
U1	Integrated Circuit, MC1662L	25778

10 MHz AMPLIFIER P.C. ASSEMBLY PARTS LIST

REF.	DESCRIPTION	SD PART NO.
A18, A19	10 MHz Amplifier P.C. Assembly	B39331
	10 MHz Amplifier Schematic	C39328
C1	Capacitor, .05 µF, 500 V	C0422
C2	Capacitor, 12 pF, 500 V	C0637
C3	Capacitor, 100 pF, 500 V	C0536
C4	Capacitor, 100 pF, 500 V	C0536
C5	Capacitor, 1000 pF, 100 V	C0543
C6	Capacitor, 33 pF, 500 V	C0531
C7	Capacitor, 180 pF, 500 V	C0707
C8	Capacitor, .01 µF, 100 V	C0556
C9	Capacitor, .01 µF, 100 V	C0556
C10	Capacitor, .01 µF, 100 V	C0556
C11	Capacitor, .01 µF, 100 V	C0556
C12	Capacitor, .01 µF, 100 V	C0556
C13	Capacitor, .01 µF, 100 V	C0556
C14	Capacitor, 220 pF, 500 V	C0538
C15	Capacitor, .001 µF, 1 kV	C0235
C16	Capacitor, .05 µF, 12 V	C0672
C17	Not Used	
C18	Capacitor, 33 pF, 500 V	C0531
C19	Capacitor, .001 µF, 1 kV	C0235
CR1	Diode, 1N4151	CR0150
CR2	Diode, 1N4151	CR0150
CR3	Diode, 1N4151	CR0150
CR4	Diode, 1N4151	CR0150
CR5	Diode, 1N4151	CR0150
CR6	Diode, 1N4151	CR0150
CR7	Diode, 1N4151	CR0150
K1	Relay, Reed, Form A, 1 kV	K0132
K2	Relay, Reed, Form A, 1 kV	K0132
K3	Relay, Reed, Form A, 250 V	K0133
K4	Relay, Reed, Form A, 250 V	K0133
Q1	Transistor, Dual FET	39843
Q2	Transistor, 2N4275	26013140
Q3	Transistor, 2N4275	26013140
Q4	Transistor, 2N4258	26004011
Q5	Transistor, 2N4258	26004011
Q6	Transistor, 2N4258	26004011
Q7	Transistor, 2N4258	26004011
Q8	Transistor, 2N4275	26013140

10 MHz AMPLIFIER P.C. ASSEMBLY PARTS LIST (Cont'd)

REF.	DESCRIPTION	SD PART NO.
Q9	Transistor, 2N4275	26013140
Q10	Transistor, 2N4258	26004011
Q11	Transistor, 2N4258	26004011
Q12	Transistor, 2N3646	Q0218
Q13	Transistor, 2N3646	Q0218
R1	Resistor, 820 k, 1/4 W, 5%	R2153
R2	Resistor, 910 k, 1/4 W, 5%	R2312
R3	Resistor, 91 k, 1/4 W, 5%	R1481
R4	Resistor, 100 k, 1/4 W, 5%	R0741
R5	Resistor, 11 k, 1/4 W, 5%	R1582
R6	Resistor, 4.7 k, 1/4 W, 5%	R0892
R7	Resistor, 1 k, Potentiometer	R2330
R8	Resistor, 200 Ω, 1/4 W, 5%	R0736
R9	Resistor, 200 Ω, 1/4 W, 5%	R0736
R10	Resistor, 4.7 k, 1/4 W, 5%	R0892
R11	Resistor, 10 Ω, 1/4 W, 5%	R0739
R12	Resistor, 10 k, 1/4 W, 5%	R0766
R13	Resistor, 1 M, 1/4 W, 5%	R0962
R14	Resistor, 1.5 k, 1/4 W, 5%	R0783
R15	Resistor, 1.5 k, 1/4 W, 5%	R0783
R16	Resistor, 100 Ω, 1/4 W, 5%	R0966
R17	Resistor, 680 Ω, 1/4 W, 5%	R1234
R18	Resistor, 1.5 k, 1/4 W, 5%	R0783
R19	Resistor, 1.5 k, 1/4 W, 5%	R0783
R20	Resistor, 680 Ω, 1/4 W, 5%	R1234
R21	Resistor, 1 k, 1/4 W, 5%	R0765
R22	Resistor, 3.3 k, 1/4 W, 5%	R0742
R23	Resistor, 1 k, 1/4 W, 5%	R0765
R24	Resistor, 680 Ω, 1/4 W, 5%	R1234
R25	Resistor, 1 k, 1/4 W, 5%	R0765
R26	Resistor, 1 k, 1/4 W, 5%	R0765
R27	Resistor, 680 Ω, 1/4 W, 5%	R1234
R28	Resistor, 5.6 k, 1/4 W, 5%	R0821
R29	Resistor, 2.2 k, 1/4 W, 5%	R0749
R30	Resistor, 1 k, 1/4 W, 5%	R0765
R31	Resistor, 1 k, 1/4 W, 5%	R0765
R32	Resistor, 5.6 k, 1/4 W, 5%	R0821
R33	Resistor, 56 Ω, 1/4 W, 5%	R1554
R34	Resistor, 56 Ω, 1/4 W, 5%	R1554
R35	Resistor, 360 Ω, 1/4 W, 5%	R1571
R36	Resistor, 5.6 k, 1/4 W, 5%	R0821
R37	Resistor, 5.6 k, 1/4 W, 5%	R0821

10 MHz AMPLIFIER P.C. ASSEMBLY PARTS LIST (Cont'd)

REF.	DESCRIPTION	SD PART NO.
R38	Resistor, 470 Ω, 1/4 W, 5%	R1044
R39	Resistor, 1 k, 1/4 W, 5%	R0765
R40	Resistor, 1 k, 1/4 W, 5%	R0765
R41	Resistor, 5.6 k, 1/4 W, 5%	R0821
R42	Resistor, 100 Ω, 1/4 W, 5%	R0966
R43	Resistor, 2.2k, 1/8 W, 5%	R1476
R44	Resistor, 4.7 k, 1/4 W, 5%	R0892
R45	Resistor, 2.7 k, 1/4 W, 5%	R0937
R46	Resistor, 2.7 k, 1/8 W, 5%	R1749
R47	Resistor, 10 Ω, 1/4 W, 5%	R0739
R48	Resistor, 10 k, 1/4 W, 5%	R0766
R49	Resistor, 2.2 k, 1/8 W, 5%	R1476
R50	Resistor, 2.7 k, 1/8 W, 5%	R1749
U1	Integrated Circuit, 7400N	19705
U2	Integrated Circuit, 7400N	19705
VR1	Diode, Breakdown, S20266	26003501
VR2	Diode, Breakdown, S20266	26003501
VR3	Diode, Breakdown, 1N957B	CR0292
VR4	Diode, Breakdown, 1N957B	CR0292

MIXER P.C. ASSEMBLY

REF.	DESCRIPTION	SD PART NO.
A20	Mixer P.C. Assembly	C33218
	Mixer Schematic	C27988
C1	Capacitor, 5 pF, Chip	C1187
C2	Capacitor, 5 pF, Chip	C1187
C3	Capacitor, .005 µF, Chip	C1245
C4	Capacitor, 5 pF, Chip	C1187
C5	Capacitor, 5 pF, Chip	C1187
C6	Capacitor, .01 µF, 100 V, Disc	C0556
C7	Capacitor, 22 pF, Chip	C1177
C8	Capacitor, .01 µF, 100 V, Disc	C0556
C9	Capacitor, .01 µF, 100 V, Disc	C0556
C10	Capacitor, 56 pF, 500 V, DM	C0882
C11	Capacitor, 56 pF, 500 V, DM	C0882
C12	Capacitor, 100 pF, 500 V, DM	C0536
C13	Capacitor, .01 µF, 100 V, Disc	C0556
C14	Capacitor, .1 µF, 10 V, Disc	C0661
C15	Capacitor, .05 µF, 12 V, Disc	C0672
C16	Capacitor, 180 pF, 500 V, DM	C1138
C17	Capacitor, .05 µF, 12 V, Disc	C0672
C18	Not Used	
C19	Not Used	
C20	Capacitor, 1 µF, 35 V, Tant	C0524
C21	Capacitor, .05 µF, 12 V, Disc	C0672
CR1	Diode, HPA-5082-2542	CR0358
CR2	Diode, HPA-5082-2542	CR0358
CR3	Diode, HPA-5082-2542	CR0358
CR4	Diode, HPA-5082-2542	CR0358
CR5	Diode, HPA-5082-2542	CR0358
CR6	Diode, HPA 5082-2800	CR0363
CR7	Diode, 1N4151	CR0150
CR8	Diode, 1N4151	CR0150
CR9	Diode, 1N4151	CR0150
Q1	Transistor, 2N3958	26015100
Q2	Transistor, 2N5459	Q0264
Q3	Transistor, SD Spec 33392	33392
R1	Resistor, 50 Ω, Chip	R2494
R2	Resistor, 50 Ω, Chip	R2494
R3	Resistor, 50 Ω, Chip	R2494
R4	Resistor, 50 Ω, Chip	R2494
R5	Resistor, 150 k, 1/4 W, 1%, MF	R2421

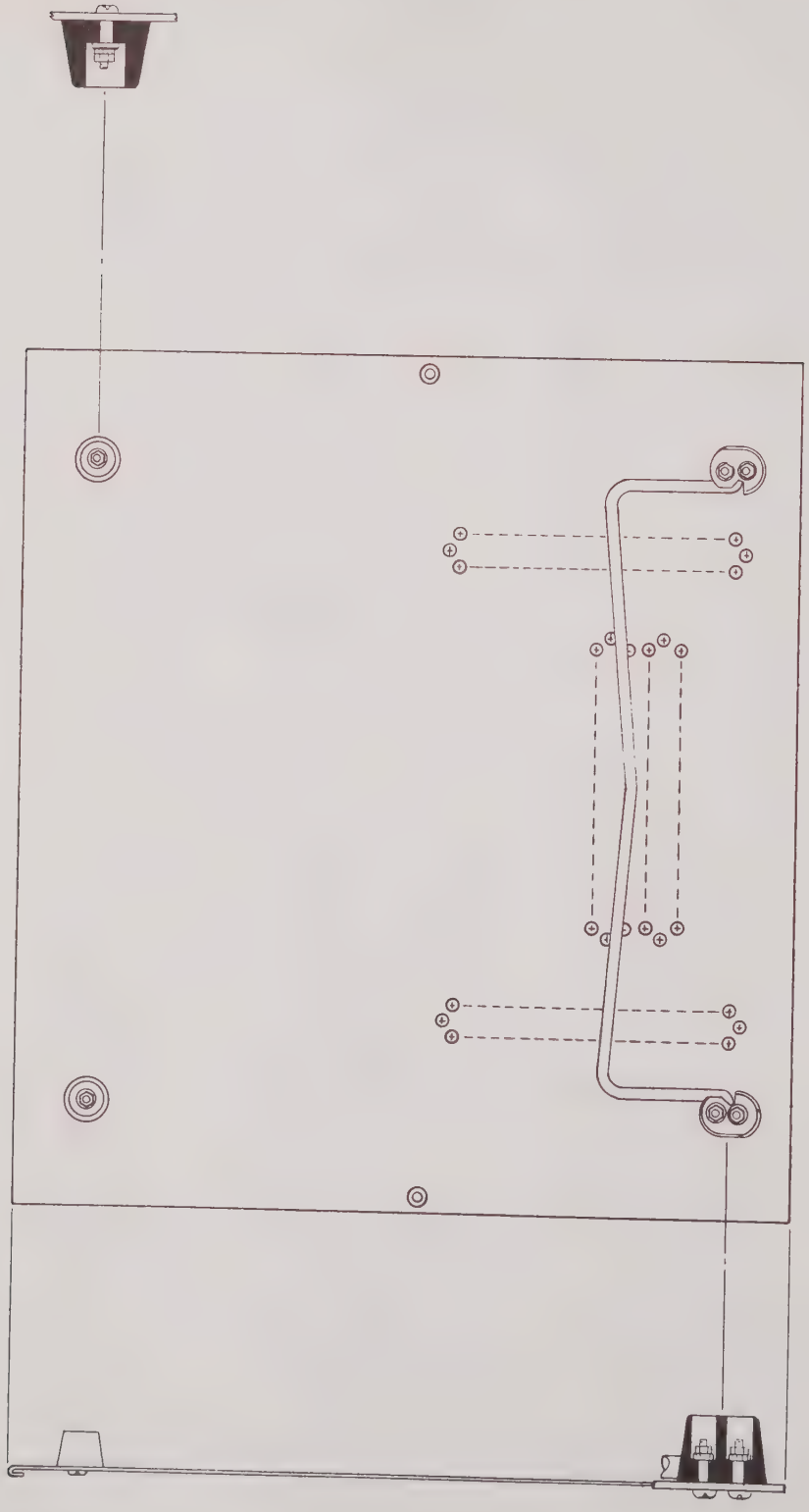
MIXER P.C. ASSEMBLY (Cont'd)

REF.	DESCRIPTION	SD PART NO.
R6	Resistor, 150 k, 1/4 W, 1%, MF	R2421
R7	Resistor, 150 k, 1/4 W, 1%, MF	R2421
R8	Resistor, 150 k, 1/4 W, 1%, MF	R2421
R9	Resistor, 50 Ω, Chip	R2494
R10	Resistor, 560 k, 1/8 W, 5%	R2536
R11	Resistor, 1 M, 1/8 W, 5%	R1435
R12	Resistor, 10 k, 1/8 W, 5%	R1437
R13	Resistor, 2.7 k, 1/8 W, 5%	R1749
R14	Resistor, 27 k, 1/8 W, 5%	R2432
R15	Resistor, 2.7 k, 1/8 W, 5%	R1749
R16	Resistor, 27 k, 1/8 W, 5%	R2432
R17	Resistor, 5 k, Potentiometer, 4 Turn	R2697
R18	Not Used	
R19	Resistor, 5 k, Potentiometer, 4 Turn	R2697
R20	Resistor, 2.2 k, 1/8 W, 5%	R1476
R21	Resistor, 2.2 k, 1/8 W, 5%	R1476
R22	Resistor, 330 k, 1/8 W, 5%	R2535
R23	Resistor, 1 k, 1/8 W, 5%	R1453
R24	Resistor, 2.4 k, 1/8 W, 5%	R2358
R25	Resistor, 2.7 k, 1/8 W, 5%	R1749
R26	Resistor, 1 k, 1/8 W, 5%	R1453
R27	Resistor, 1 k, 1/8 W, 5%	R1453
R28	Resistor, 3.9 k, 1/8 W, 5%	R1457
R29	Resistor, 390 Ω, 1/8 W, 5%	R1450
R30	Resistor, 4.7 k, 1/8 W, 5%	R1733
R31	Resistor, 680 Ω, 1/8 W, 5%	R2461
R32	Resistor, 3.3 k, 1/8 W, 5%	R1456
R33	Resistor, 10 k, 1/8 W, 5%	R1437
R34	Resistor, 10 k, 1/8 W, 5%	R1437
R35	Resistor, 6.8 k, 1/8 W, 5%	R1459
R36	Resistor, Selected	Rxxxx
R37	Resistor, 3.3 k, 1/8 W, 5%	R1456
R38	Resistor, 100 k, 1/8 W, 5%	R2465
R39	Resistor, 1 k, 1/8 W, 5%	R1453
R40	Resistor, 100 k, 1/8 W, 5%	R2465
R41	Resistor, 1 k, 1/8 W, 5%	R1453
R42	Resistor, 680 Ω, 1/8 W, 5%	R2461
R43	Resistor, 4.7 k, 1/8 W, 5%	R1733
U1	Integrated Circuit, CA3029	25757
U2	Integrated Circuit, LM301A	25745
U3	Integrated Circuit, CA3046	25725

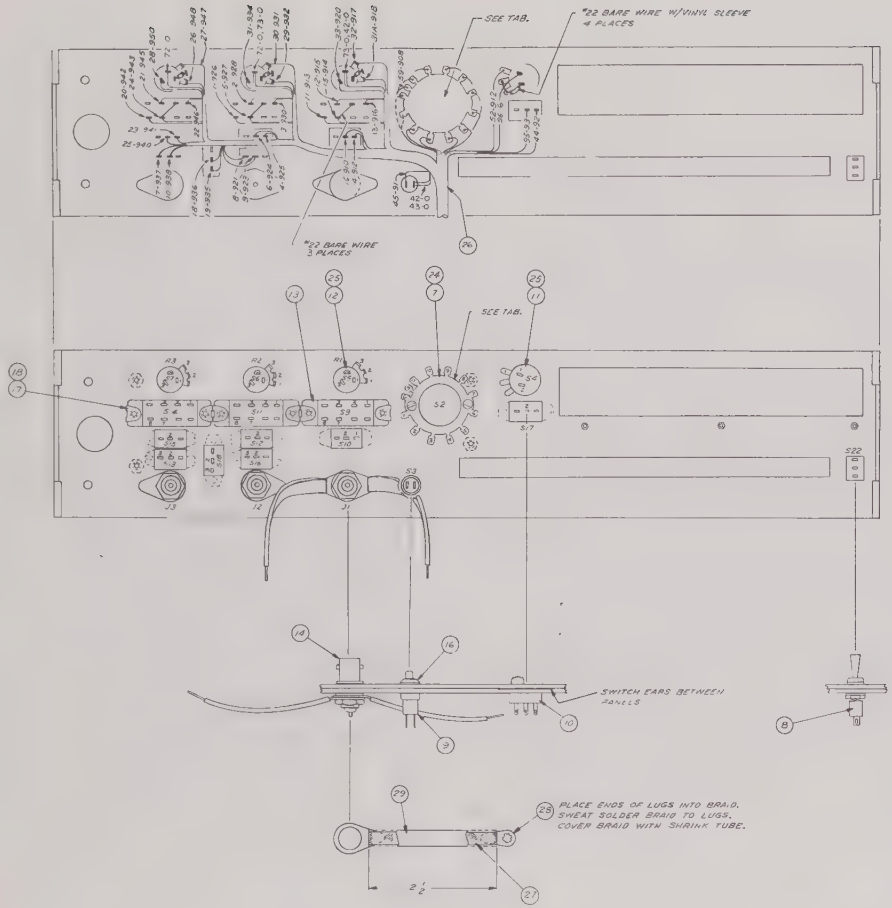
DRIVER AMPLIFIER P.C. ASSEMBLY

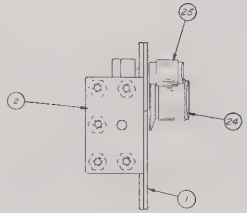
REF.	DESCRIPTION	SD PART NO.
A20	Driver Amplifier P.C. Assembly	C33221
	Driver Amplifier Schematic	
C101	Capacitor, 15 pF, Chip	C1163
C102	Capacitor, 15 pF, Chip	C1163
C103	Capacitor, 22 pF, Chip	C1177
C104	Capacitor, 15 pF, Chip	C1163
C105	Capacitor, 15 pF, Chip	C1163
C106	Capacitor, 22 pF, Chip	C1177
C107	Capacitor, .05 µF, 12 V	C0672
C108	Capacitor, .05 µF, 12 V	C0672
C109	Not Used	
C110	Not Used	
C111	Capacitor, .05 µF, 12 V	C0672
C112	Capacitor, .05 µF, 12 V	C0672
C113	Capacitor, 100 µF, 10 V	C0660
C114	Capacitor, .05 µF, 12 V	C0672
C115	Capacitor, 68 pF, 500 V	C0635
C116	Capacitor, 68 pF, 500 V	C0635
C117	Capacitor, 100 µF, 10 V	C0660
CR101	Diode, HP0151	CR0269
CR102	Diode, HP0151	CR0269
L101	Inductor, 100 µH, 10%	L0073
L102	Inductor, 100 µH, 10%	L0073
Q101	Transistor, 2N3646	Q0218
Q102	Transistor, 2N3646	Q0218
Q103	Transistor, 2N3646	Q0218
Q104	Transistor, 2N3646	Q0218
Q105	Transistor, 2N3640	Q0178
Q106	Transistor, 2N3640	Q0178
R101	Resistor, 150 Ω, 5%, 1/4 W	R0983
R102	Resistor, 150 Ω, 5%, 1/4 W	R0983
R103	Resistor, 150 Ω, 5%, 1/4 W	R0983
R104	Resistor, 270 Ω, 5%, 1/4 W	R0694
R105	Resistor, 47 Ω, 5%, 1/4 W	R0743
R106	Resistor, 47 Ω, 5%, 1/4 W	R0743
R107	Resistor, 330 Ω, 5%, 1/4 W	R0662
R108	Resistor, 330 Ω, 5%, 1/4 W	R0662
R109	Resistor, 470 Ω, 5%, 1/4 W	R1044
R110	Resistor, 1 k, 5%, 1/4 W	R0765

MODEL 6153-50 FINAL CABINET ASSEMBLY



BOTTOM COVER ASSEMBLY #C39644A



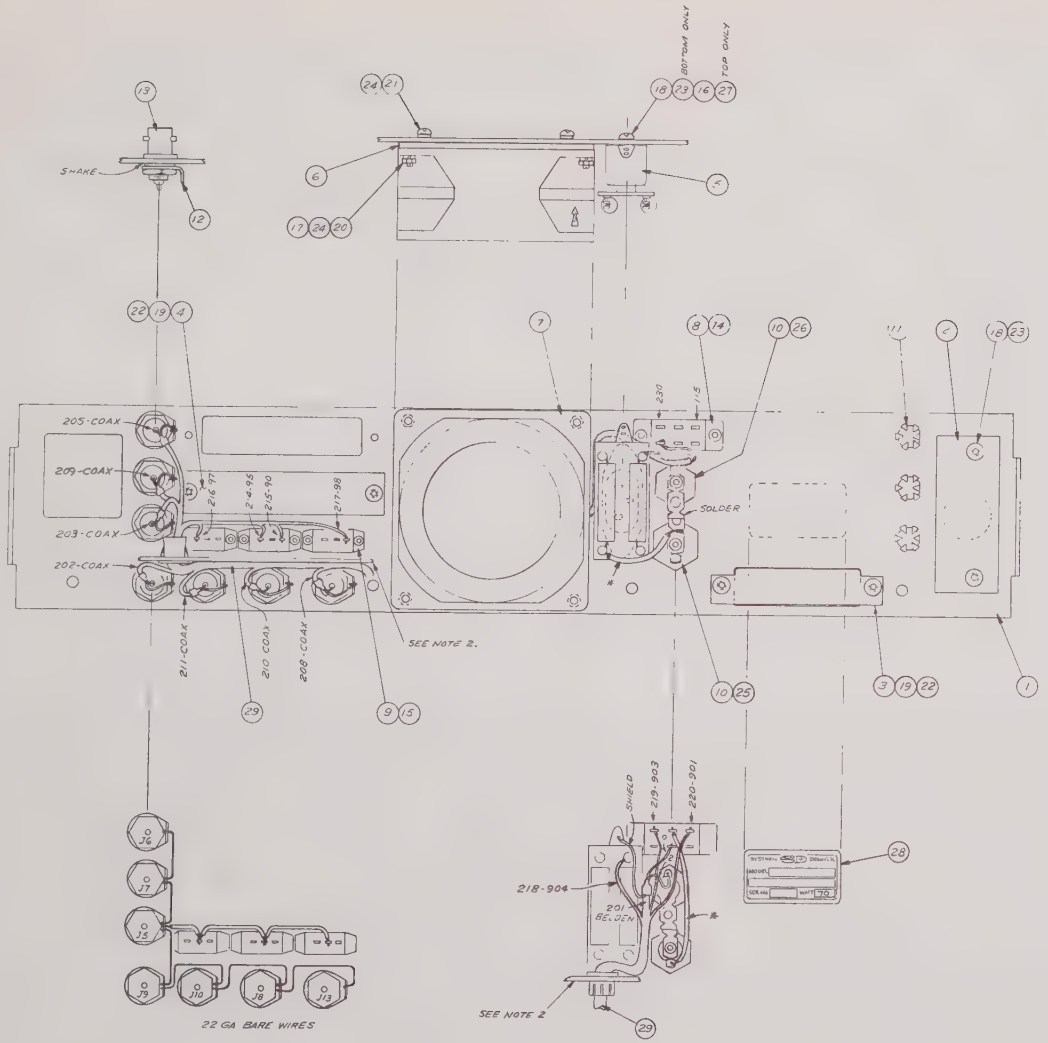


S2 WIRING TABULATION

LUG	39655 STOP POSITION BETWEEN 10 & 11	39656 STOP POSITION BETWEEN 12 & 1
1	36-97	N.C.
2	51-96	36-97
3	35-33	51-96
4	48-900	35 33
5	49-901	48-900
6	50-902	49-901
7	60-903	50-902
8	61-904	60-903
9	62-905	61-904
10	63-906	62-905
11	64-907	63-906
12	N.C.	64-907
S	59-908	59-908

ITEM NO	QTY	PART NUMBER	DESCRIPTION	SCHEMATIC REF NO
30				
29	2		SHRINK TUBE (2½ LONG)	
28	2	H-1727	GND LUG #6	
27	2	W2	BRAID	
26	1	C39719	FRONT PANEL CABLE ASS'Y	
25	4	H-1964	KNOB, ROUND	
24	1	H-1965	KNOB, BAR	
23				
22				
21				
20				
19				
18	6	H-1798	SCREW, 4-40 x 3/16 FHMS	
17	6	H-0268	PUSH NUT, 4-40	
16	1	H-1837	NUT, DECORATIVE	
15	4	E-0137	GROUND LUG, BNC	
14	3	J-0260	CONNECTOR, BNC	J1, J2, J3
13	3	S-0399	SWITCH, SLIDE, DPTT	S9, S11, S14
12	3	A 2077	SWITCH E POT, SPDT 5K	R1-55, R2-56, R3-57
11	1	A-2702	SWITCH E POT, SPST 2M	R3 54
10	7	05034990	SWITCH, SLIDE, SPDT	S10, S12, S13, S15, S16, S17, S18
9	1	S-0398	SWITCH, PUSHBUTTON N.O.	S3
8	1	S-0397	SWITCH, TOGGLE W/BLACK DECORATIVE NUT	S22
7	1	A 39655	SWITCH, ROTARY	S2
6				
5				
4				
3				
2	1	D-39413	[illegible]	
1	1	D-39-[illegible]	[illegible] PANEL	

FRONT PANEL ASSEMBLY #D39188C

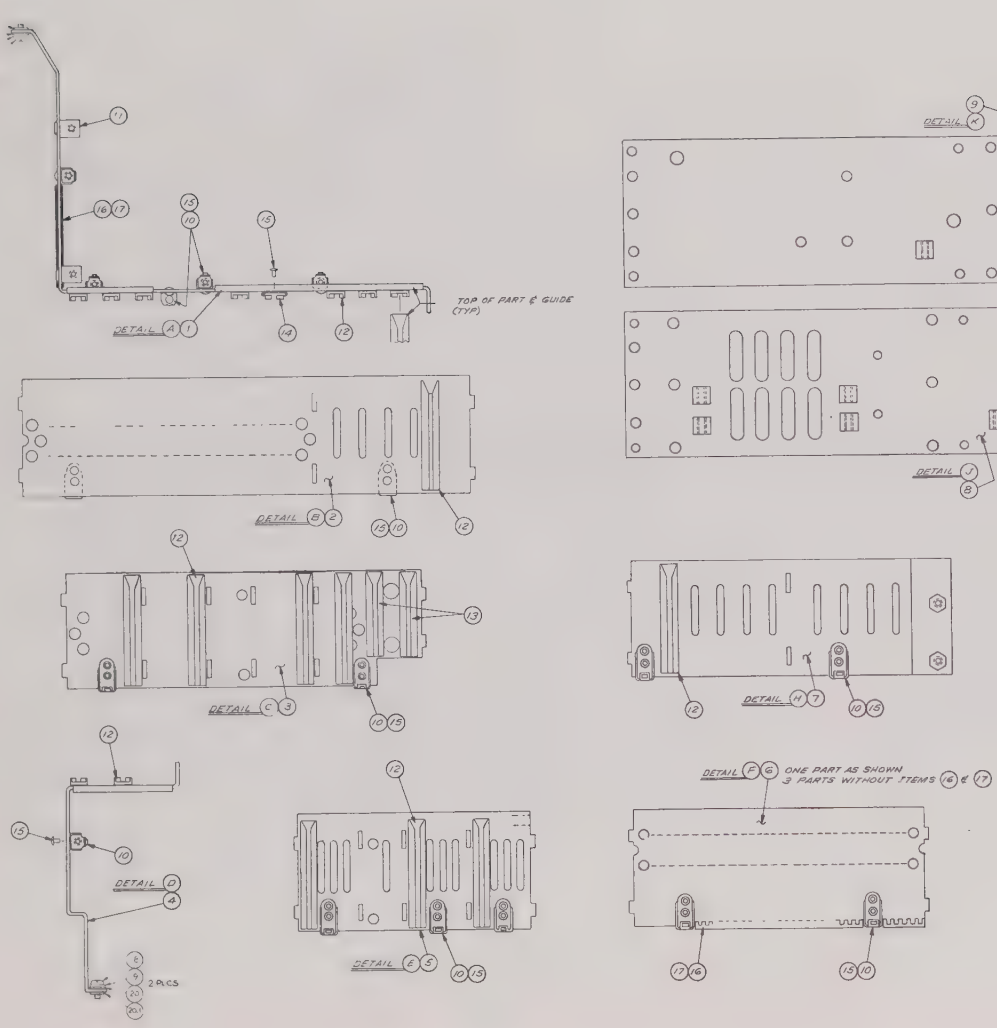


NOTE

1) *- DENOTES 20GA. BARE WIRE W/TEFLON SLEEVE (2 PLACES)
2) CHASSIS LEVEL SHOWN FOR REF ONLY.

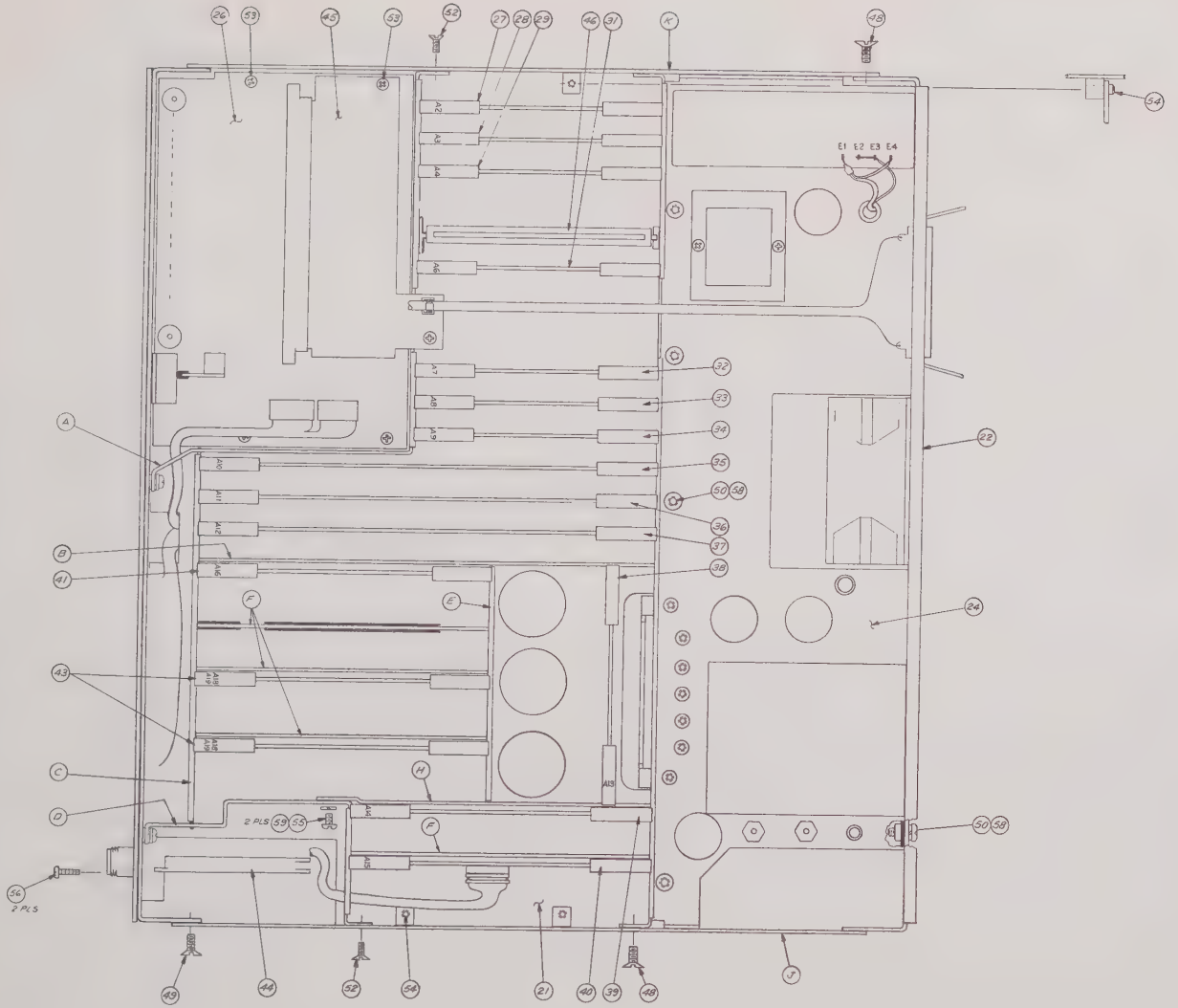
ITEM NO	QTY	PART NUMBER	DESCRIPTION	SCHEMATIC REF NO
30				
29	1	C-39936	REAR PANEL CABLE ASS'Y	
28		A 23456	NAMEPLATE	
27	1	E-0193	GROUND LUG #4	
26		F-0005	FUSE, 1A SLO-BLO	F1
25	1	F-0067	FUSE, $\frac{1}{8}$A SLO-BLO	F2
24	8	H-0783	WASHER, #6 SPLIT LOCK	
23	3	H-0782	WASHER, #4 SPLIT LOCK	
22	4	H-0481	WASHER, #2 SPLIT LOCK	
21	4	H-0989	SCREW, 6-32 x $\frac{3}{8}$ PHMS PHILLIPS HD.	
20	4	H-0379	SCREW, 6-32 x $\frac{5}{8}$ FHMS PHILLIPS HD.	
19	4	H-0433	SCREW, 2-56 x $\frac{1}{4}$ PHMS PHILLIPS HD.	
18	4	H-0440	SCREW, 4-40 x $\frac{1}{2}$ PHMS PHILLIPS HD	
17	4	H-0762	NUT, # 6-32	
16	2	H-0249	NUT, #4-40	
15	6	H-1841	RIVET, .088 x .125 LONG	
14	2	H-0404	RIVET, TUBULAR $\frac{1}{8}$ DIA. x $\frac{1}{8}$ LONG	
13	7	J-0165	CONNECTOR, BNC	J5 THRU J10, J13
12	7	E-0137	GND LUG, BNC	
11	3	H-1667	SNAP BUTTON	
10	2	X-0034	FUSE HOLDER	
9	3	05034990	SLIDE SWITCH, SPDT	S8,S20,S23
8	1	S-0384	SLIDE SWITCH, DPDT	S21
7	1	H-1786	FAN	B1
6	1	B39614	PLATE, FAN MOUNTING	
5	1	A-31391-4-1	FILTER ASS'Y, AC LINE	
4	1	A-39443-2	COVER PLATE, 50 PIN	
3	1	A-39421	COVER PLATE, 36 PIN	
2	1	A39442	COVER PLATE, MIXER	
1	1	D39314	REAR PANEL	

REAR PANEL ASSEMBLY #D39187D



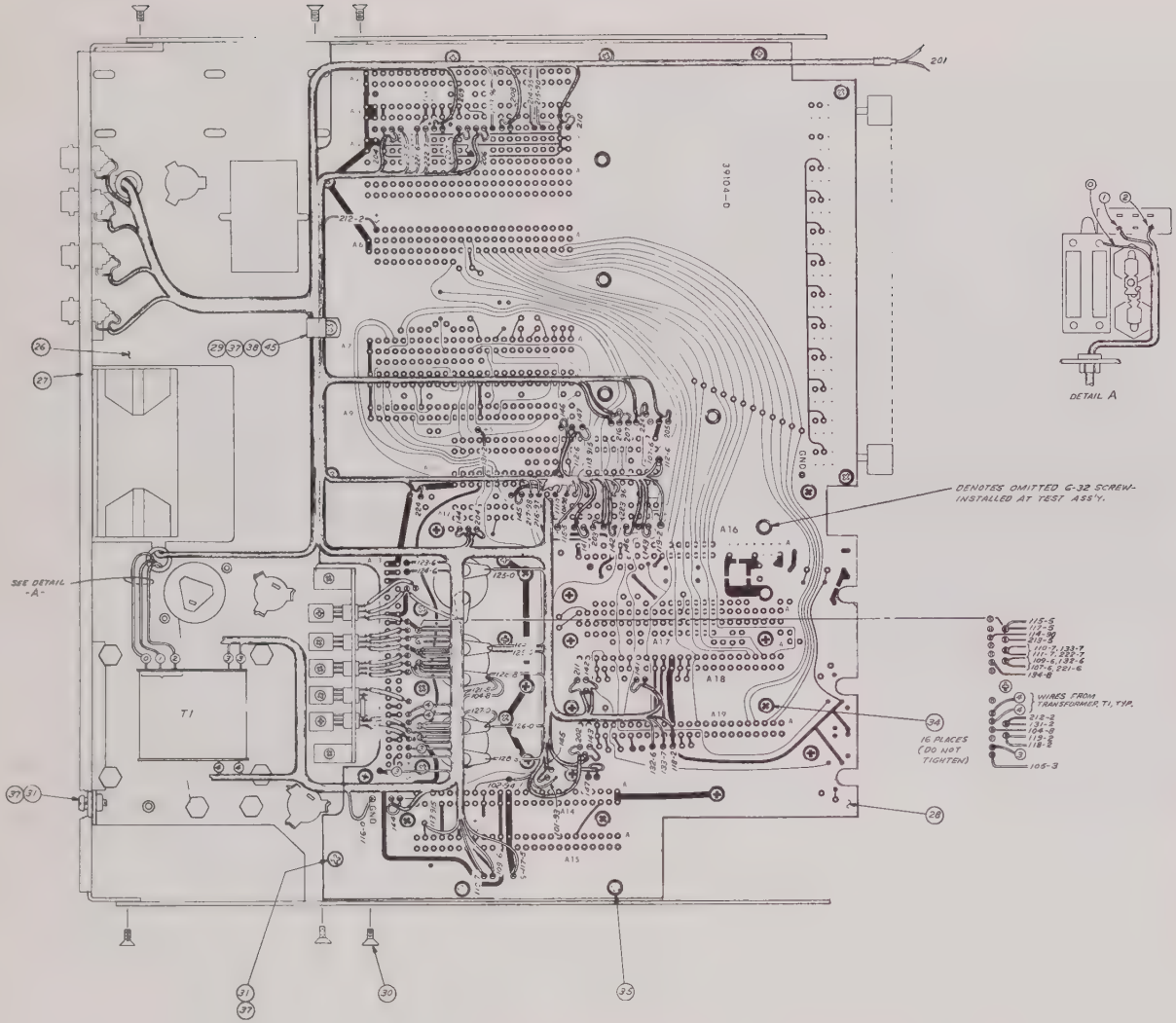
20.1	4	H1476	WASHER, NO 4 FLAT NYLON
20	4	62003670	WASHER, NO 6 FLAT
19	4	H 0410	WASHER, NO 6 INTERNAL TOOTH
18	4	H 0986	SCREW, 6-32 X 1/4 PHMS
17	A/R	~	ADHESIVE, EASTMAN 910
16	A/R	H-1829	CATERPILLER STRIP
15	36	H-1841	RIVET, .088 DIA. X .145 LONG
14	1	H-1826	PC GUIDE (BIRTCHER CLIP)
13	2	A39567	PC GUIDE, NYLON, MODIFIED
12	18	A21340-1-1	PC GUIDE, NYLON
11	9	E-0117	SWAGE NUT, RIGHT ANGLE 6-32
10	16	610391 20	RIGHT ANGLE FLOATING NUT, 6-32
9	1	C39437	GUSSET, RIGHT
8	1	C39436	GUSSET, LEFT
7	1	B39388	SIDE SUPPORT
6	4	B39390	CAGE, RUNNER
5	1	B39389	CAGE, CENTER PLATE
4	1	C39386	CAGE, RIGHT SIDE
3	1	C39154	CAGE, FRONT PLATE
2	1	C39387	CAGE, CENTER DIVIDER
1	1	C39155	CAGE, LEFT SIDE
ITEM NO.	QTY	PART IDENTIFYING NO.	DESCRIPTION	REFERENCE DES NO.

TEST ASSEMBLY #D39641B (SHEET 1 OF 2)



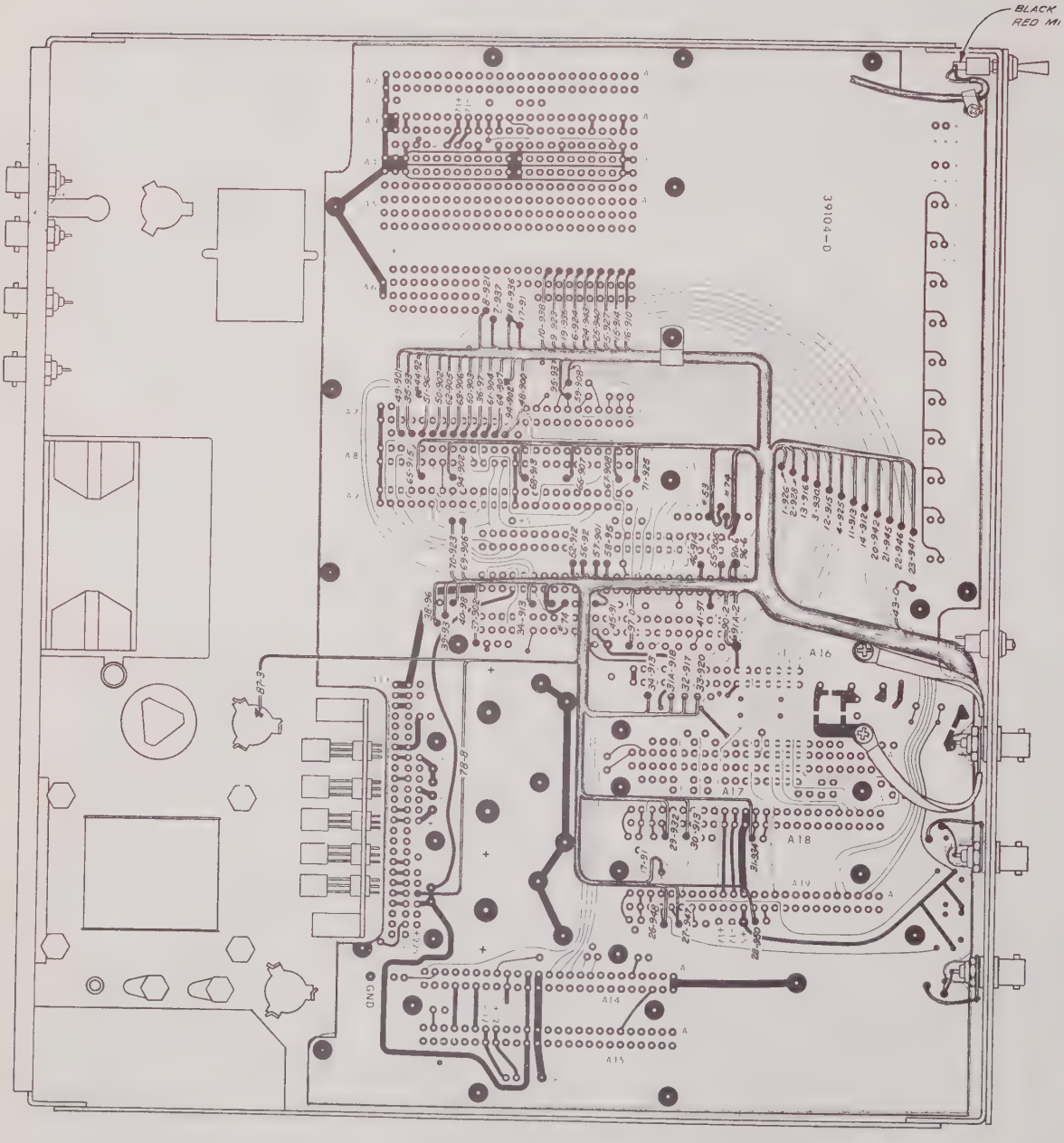
ITEM NO.	QTY.	PART NUMBER	DESCRIPTION	SCHEMATIC REF NO.
60				
59	28	H-0783	WASHER, #6 SPLIT-LOCK	
58	4	H-0784	WASHER, #8 SPLIT-LOCK	
57				
56	2	H-0376	SCREW, 4-40 x 5/16 PHMS	
55	2	H-0986	SCREW, 6-32 x 1/4 PHMS	
54	5	H-0551	SCREW, 6-32 x 5/16 FILLISTER HMS	
53	28	H-0989	SCREW, 6-32 x 5/16 PHMS (22 THRU M8 INTO FLOATING NUT)	
52	4	H-0430	SCREW, 6-32 x 3/4 FHMS	
51				
50	8	H-0987	SCREW, 8-32 x 5/16 PHMS	
49	6	H-1756	SCREW, 8-32 x 1/2 FHMS	
48	13	H-0659	SCREW, 8-32 x 5/16 FHMS	
47				
46	1	B 39153	EXTENDER PC ASS'Y	
45	1	B39379	BCD OUTPUT PC ASS'Y	A21
44	1	B39784	MIXER CABLE ASS'Y	A20
43	2	B39331	10 MHz AMP PC ASS'Y	A18, A19
42				
41	1	B39323	200 MHz AMP PC ASS'Y	A16
40	1	C39371	SHIFTER PC ASS'Y	A15
39	1	B39375	N COMPUTER PC ASS'Y	A14
38	1	B39351	MAIN POWER PC ASS'Y	A13
37	1	C39327	200MHz DECADE & GATE PC ASS'Y	A12
36	1	C39343	FUNCTION CONTROL PC ASS'Y	A11
35	1	C39347	TIME BASE PC ASS'Y	A10
34	1	C39339	DECIMAL LOGIC PC ASS'Y	A9
33	1	B39335	LEGEND LOGIC PC ASS'Y	A8
32	1	B39803	FUNCTION SELECT PC ASS'Y	A7
31	1	B39355	ATTEN. SELECT PC ASS'Y	A6
30				
29	1	B39363	100 MHz MULT. PC ASS'Y	A4
28	1	B39359	10 MHz OSC PC ASS'Y	A3
27	1	B39367	3 MHz OSC POWER PC ASS'Y	A2
26	1	C39383	READOUT PC ASS'Y	A1
25				
24	1	D39189	POWER SUPPLY CHASSIS ASS'Y	
23	1	D39188	FRONT PANEL ASS'Y	
22	1	D39187	REAR PANEL ASS'Y	
21	1	C 39114	MOTHER BD. PC ASS'Y	

TEST ASSEMBLY #D39641B (SHEET 2 OF 2)



ITEM NO	QTY	PART NUMBER		SCHEMATIC REF NO
45	1	H-0790	CABLE CLAMP, 5/16	
44				
43				
42				
41				
40				
39	2	H-0783	WASHER, #6 SPLIT	
38	1	H-0760	WASHER #8 FLAT	
37	8	H-0784	WASHER #8 SPLIT	
36				
35	5	H-0551	SCREW, 6-32 x 3/8 FILLISTER HMS	
34	16	H 1281	SCREW, 6-32 x 5/16 PHMS	
33				
32	4	H-C430	SCREW, 6-32 x 1/8 FHMS	
31	7	H-0987	SCREW, 8-32 x 3/8 PHMS	
30	12	H-0659	SCREW, 8-32 x 5/16 FHMS	
29	1	H-1748	SCREW, 8-32 x 7/16 PHMS	
28	1	C39114	MOTHER BOARD PC ASS'Y	
27	1	D39187	REAR PANEL ASS'Y	
26	1		POWER SUPPLY CHASSIS ASS'Y	

UNIVERSAL CHASSIS/CABLE ASSEMBLY#D39895B (SHEET 1 OF 2)



UNIVERSAL CHASSIS/CABLE ASSEMBLY #D39895 (SHEET 2 OF 2)

FRONT PANEL CABLE ASSEMBLY

NO.	COLOR	FROM	TO
17	91	A19-Z	A6-13
94	902	A8-18	A7-N
34	913	A16-24	A11-X
51	96	A7-21	S2-3
36	97	A7-16	S2-2
64	907	A7-14	S2-13
59	908	A7-J	S2-12
63	906	A7-18	S2-11
62	905	A7-19	S2-10
35	93	A7-22	S2-4
48	900	A7-13	S2-5
49	901	A7-23	S2-6
50	902	A7-20	S2-7
60	903	A7-17	S2-8
61	904	A7-15	S2-9
96	6	A11-A	S4-1
52	912	A11-T	R11-1
95	93	A7-H	S17-2
44	92	A7-Y	517-1
69	906	P17-1	A9-17
70	923	P17-3	A9-18
71	925	P17-4	A9-B
46	914	P17-6	A11-D
87	3	P17-7	A13-C
65	915	P17-8	A8-21
68	913	P17-9	A8-11
78	8	P17-10	A13-F
67	908	P17-12	A8-2

NO.	COLOR	FROM	TO
66	907	P17-13	A8-7
55	905	P17-14	A11-B
90	6	P16-1	A11-A
39	93	P16-2	A12-AA
38	96	P16-3	A12-25
40	98	P16-4	A12-BB
37	902	P16-5	A12-24
91	2	P16-6	A12-1
97	0	P16-8	A12-11
91A	2	P16-9	A12-1
57	901	P16-10	A11-R
41	97	P16-11	A12-C
58	95	P16-12	A11-P
53	---	P16-13	A10-4
---	0	P16-7	A10 GND
56	92	P16-14	A11-5
42	0	S3-2	R1-2
43	0	S3-2	MB GL
45	91	S3-1	A11-14
8	921	S16-3	A6-15
9	923	S16-2	A6-J
19	935	S18-3	A6-11
18	936	S18-2	A6-13
10	938	S13-2	A6-K
7	937	S13-3	A6-14
25	940	S15-2	A6-D
23	941	S15-1	A6-2
24	943	S14-7	A6-E

NO.	COLOR	FROM	TO
20	942	S14-8	A6-4
22	946	S14-1	A6-1
26	948	R3-1	A19-22
21	945	S14-3	A6-3
28	950	S7-3	A19-13
27	947	R3-3	A19-21
72	0	R3-2	R2-2
6	924	S12-2	A6-F
4	925	S12-1	A6-7
5	927	S11-7	A6-C
3	930	S11-1	A6-9
1	926	S11-8	A6-12
2	928	S11-3	A6-11
29	923	R2-1	A18-22
31	934	S6-3	A18-13
30	913	R2-3	A18-21
73	0	R2-2	R1-2
16	910	S10-2	A6-A
14	912	S10-1	A6-5
13	916	S9-1	A6-10
15	914	S9-7	A6-B
31A	918	R1-1	A16-X
12	915	S9-3	A6-8
11	913	S9-8	A6-6
32	917	R1-3	A16-W
33	920	S5-3	A16-18
74	---	A12-U	A10-C

REAR PANEL CABLE ASSEMBLY

NO.	COLOR	FROM	TO
201	2	S21	F1 TOP
201	0	S21	S21-SW
201	SHLD	S21	GL
202	---	A19-CC	J9
203	---	A12-H	J5
204	---	A12-Y	A4-22
205	---	A10-3	J6
206	---	A10-F	A3-12
207	---	A10-6	A3-R

NO.	COLOR	FROM	TO
208	---	A3-10	J13
209	---	A3-T	J7
210	---	A3-B	J8
211	---	A18-CC	J10
212	2	A13-E	A6-BB
213	5	A13-V	A4-Y
214	95	A3-E	S20-1
215	90	A3-C	S20-3
216	97	A11-15	S23-1

NO.	COLOR	FROM	TO
217	98	A11-16	S8-3
218	904	T2-4	L2-C8
219	903	T2-3	S21-4
220	901	T2-1	S21-6
221	6	A13-N	A3-V
222	7	A13-S	A3-U
223	96	A11-6	A3-P
224	---	A12-CC	A10-4

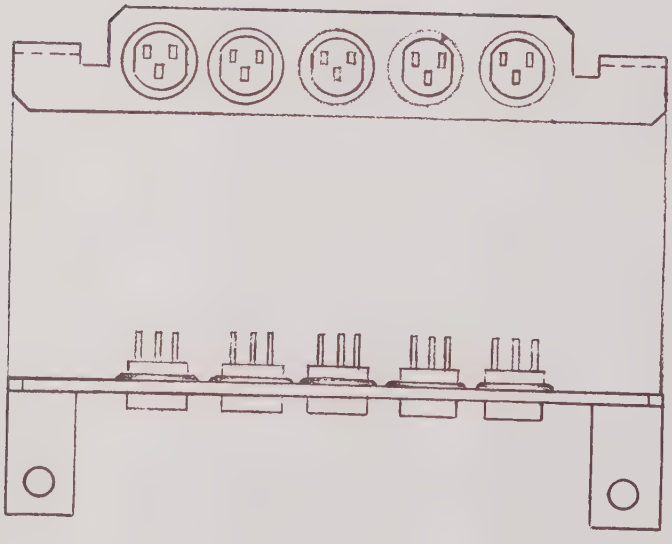
POWER SUPPLY CABLE ASSEMBLY

NO.	COLOR	FROM	TO
101	93	A14-K	A11-12
102	94	A14-V	A11-M
103	0	GL	C1 -
104	8	C5 +	A13-F
105	3	C1 +	A13-C
106	0	C3 +	C1 -
107	6	A13-N	A11-A
109	6	A13-N	A15-18
110	7	A13-S	A15-19
111	7	A13-S	A12-P
112	6	A12-M	A11-A
113	915	A15-BB	A12-9

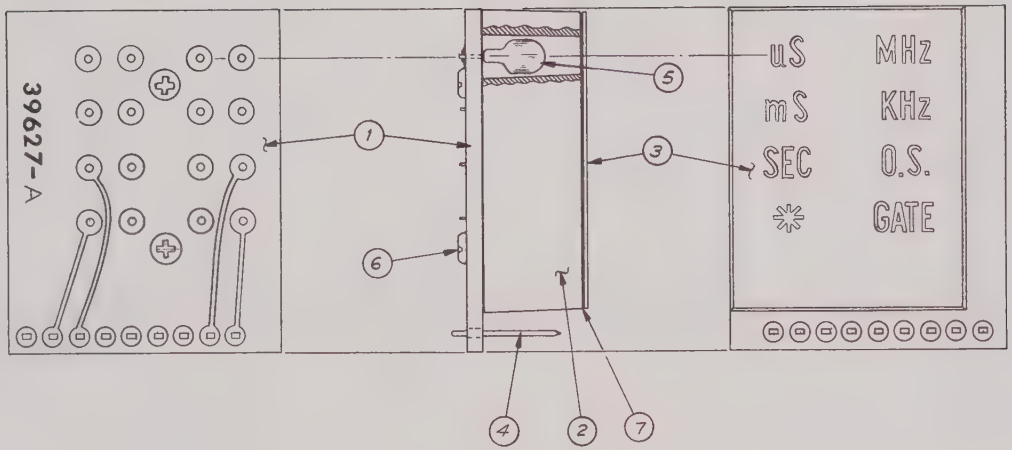
NO.	COLOR	FROM	TO
114	90	C3 -	A13-16&T
115	5	A13-V	A12-14&R
116	0	GL	MB-GND
117	5	A13-V	A15-14
118	2	A13-E	A19-14
119	2	A13-E	A12-1
121	8	CR1&2	C4 +
123	6	CR1	A13-24&23
124	6	CR2	A13-24&BB
125	0	C5 -	C6 +
126	0	C4 -	C5 -
127	0	GL	C4 -

NO.	COLOR	FROM	TO
128	8	C4 +	C5 +
131	2	A13-E	A10-22
132	6	A13-N	A19-16
133	7	A13-S	A19-15
134	8	C2 +	A13-P&13
141	---	A12-K	A18-W
142	---	A12-6	A18-BB
143	---	A19-BB	A12-2
144	---	A12-20	A14-BB
145	---	A14-L	A12-U
146	---	A12-4	A10-13
147	---	A10-11	A14-E

WIRE LIST, UNIVERSAL CHASSIS/CABLE ASSEMBLIES

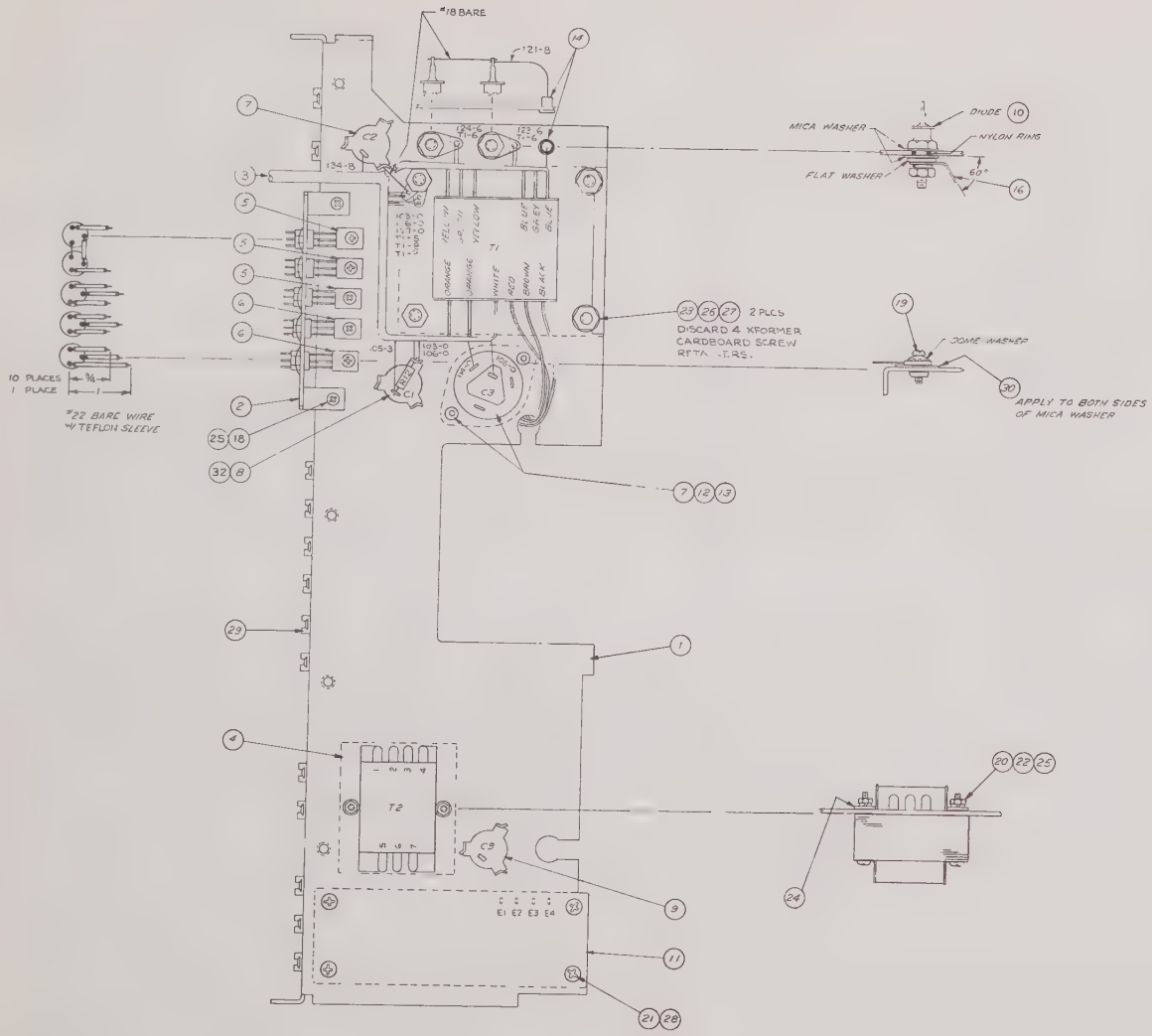


TRANSISTOR BRACKET ASSEMBLY #A39624A



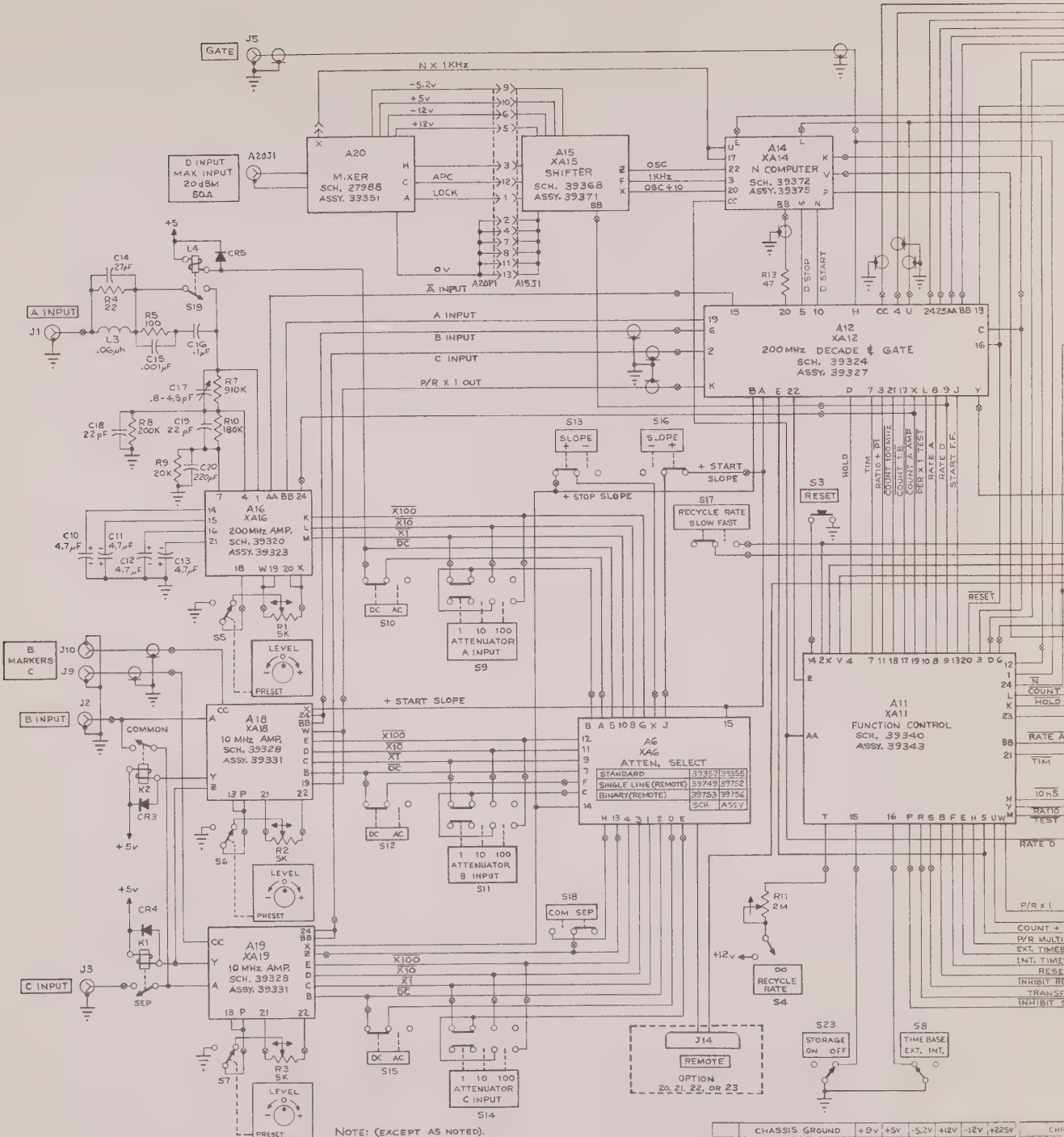
ITEM NO.	QTY.	PART NUMBER	DESCRIPTION	SCHEMATIC REF. NO.
10				
9				
8				
7	A/R	H-1768	PRESSURE SENSITIVE TAPE	
6	2	H-1271	SCREW, N° 2 x 1/4, TYPE B, PHILLIPS HD.	
5	8	I-0101	LAMP, INCANDESCENT (CM7220)	
4	?	E-0322	AMP-MODU POST STRIP, 86690-4	
3	1	A 39440	SPEC, ANNUNCIATOR LEGEND FILM	
2	1	C 27873	ANNUNCIATOR BLOCK	
1	1	B 39627	ANNUNCIATOR P.C. BOARD	

ANNUNCIATOR ASSEMBLY #C39186A



35				
34				
33				
32	1	R0283	RESISTOR, ½W, 5% 180K	R12
31				
30	A/R	H-1055	THERMAL COMPOUND	
29	13	A21340	PC GUIDE	
28	4	H-1274	WASHER, #6 SPLIT LOCK	
27	4	H-0960	WASHER, #8 SPLIT LOCK	
26	2	H-0735	WASHER, #8 FLAT	
25	4	H-0782	WASHER, #4 SPLIT LOCK	
24	2	H-0758	WASHER, #4 FLAT	
23	4	H-0463	NUT, N° 8-32	
22	2	H-0293	NUT, N° 4-40	
21	4	H-0989	SCREW, 6-32 x 3/8 PHMS PHILLIPS HD.	
20	2	H-0549	SCREW, 4-40 x 1 PHMS PHILLIPS HD.	
19	5	H-0745	SCREW, 4-40 x 3/8 PHMS PHILLIPS HD.	
18	2	H-1273	SCREW,	
17	2	E-0112	N° 8 GND LUG	
16	2	E-0137	GND LUG	
15				
14	1	H 0883	GROMMET, HEYCO SB 250-2	
13	2	H 0437	RIVET, SEMI-TUBULAR, 1/8 DIA. x 5/32 LONG	
12	1	H-0488	CAPACITOR MTG WAFER	
11	1	B 33428	OSCILLATOR, B3	U1
"	2	CR 0337	DIODE, MR1120R	CR1,CR2
"	1	03286060	CAPACITOR, 500μF, 50v	C3
9	"	C1150	CAPACITOR, 20μF 450v	C1
7	2	C3287050	CAPACITOR, 1100μF 25v	C2,C4
6	2	Q-0300	TRANSISTOR, 2N5193	Q4,Q5
5	3	Q 0281	TRANSISTOR, 2N5190	Q1 Q2,Q3
4	1	B 19805	TRANSFORMER	T2
3	1	C 39932	POWER SUPPLY CABLE ASSY	
2	1	A-39624	TRANSISTOR BRACKET ASS'Y	
1	1	D39315	CHASSIS, POWER SUPPLY	
ITEM NO	QTY	PART NUMBER		SCHEMATIC REF NO

POWER SUPPLY CHASSIS ASSEMBLY #D39189B



NOTE: (EXCEPT AS NOTED).

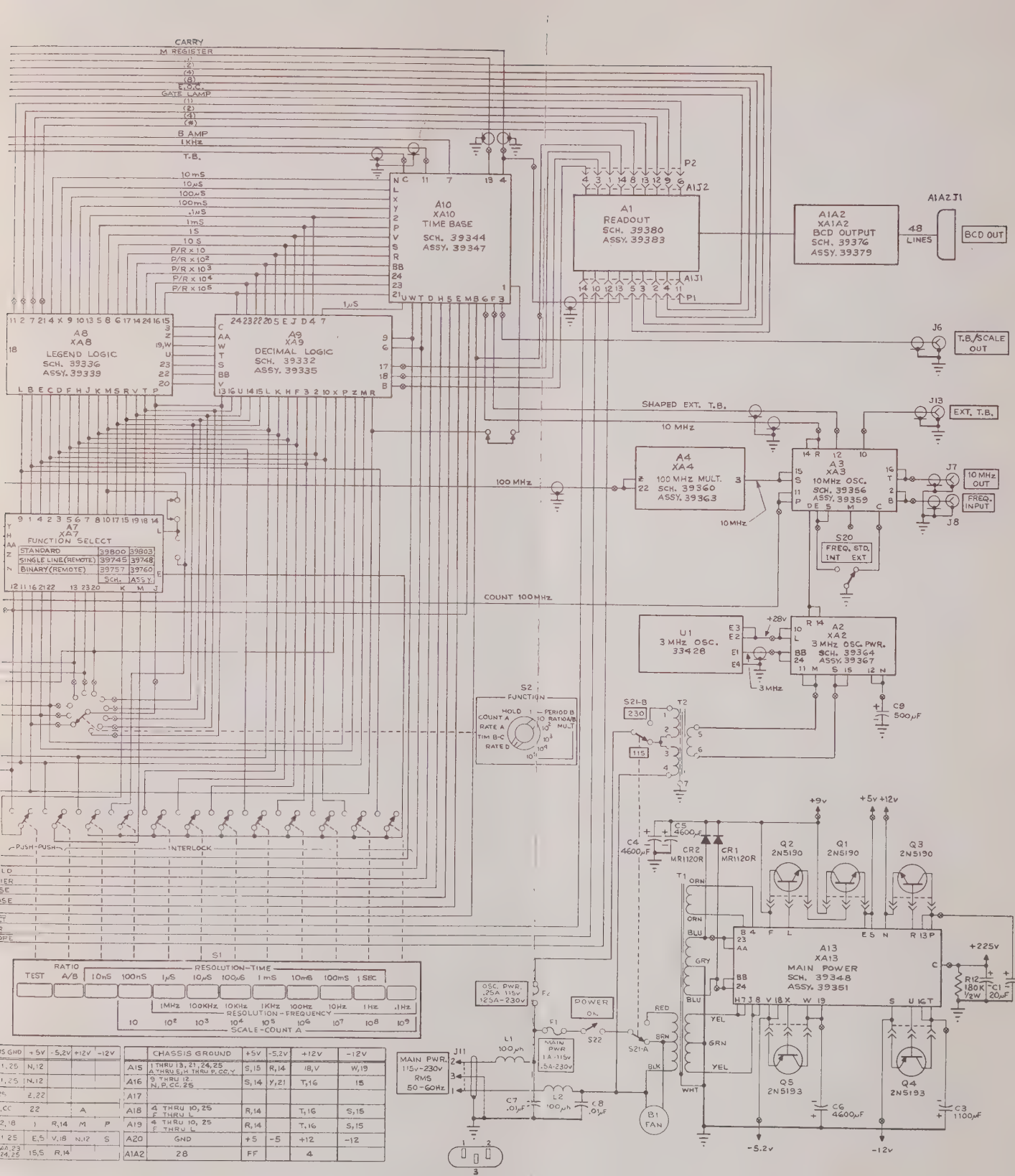
1) RESISTORS: VALUE IN OHMS. POWER 1/4 W. TOL. 5%.

2) DIODES ARE IN4151.

3) —⊗— DENOTES WIRE CONNECTIONS TO MOTHER PC BOARD.

	CHASSIS GROUND	+9v	+5v	-5.2v	+12v	-12v	+225v
A1	7, 8 (J16)	10(J17)	6,9(J16)		1(J16)		7(J17)
A2	AA, CC, J, 23, 25		W, 19				
A3	BB, CC, 24, 25		X, 20		V, 18	U, 17	
A4	A, B, N, P, AA, BB, CC, 1, 2, 12, 13, 23, 24, 25		W	Y			
A5							
A6	CC, 25		BB				
A7	CC, 25		BB				

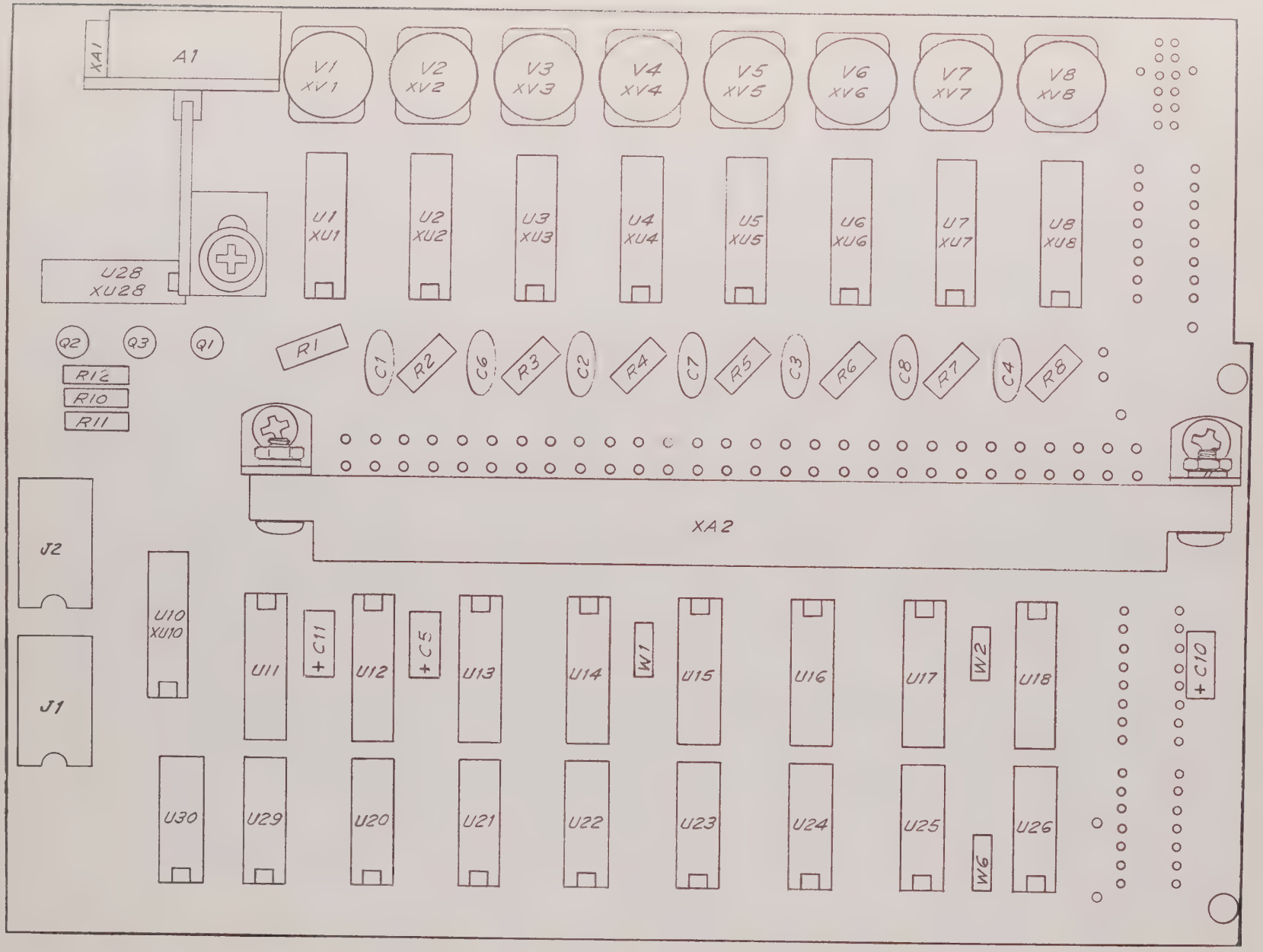
CHA
A8
A9
A10
A11
A12
A13
A14



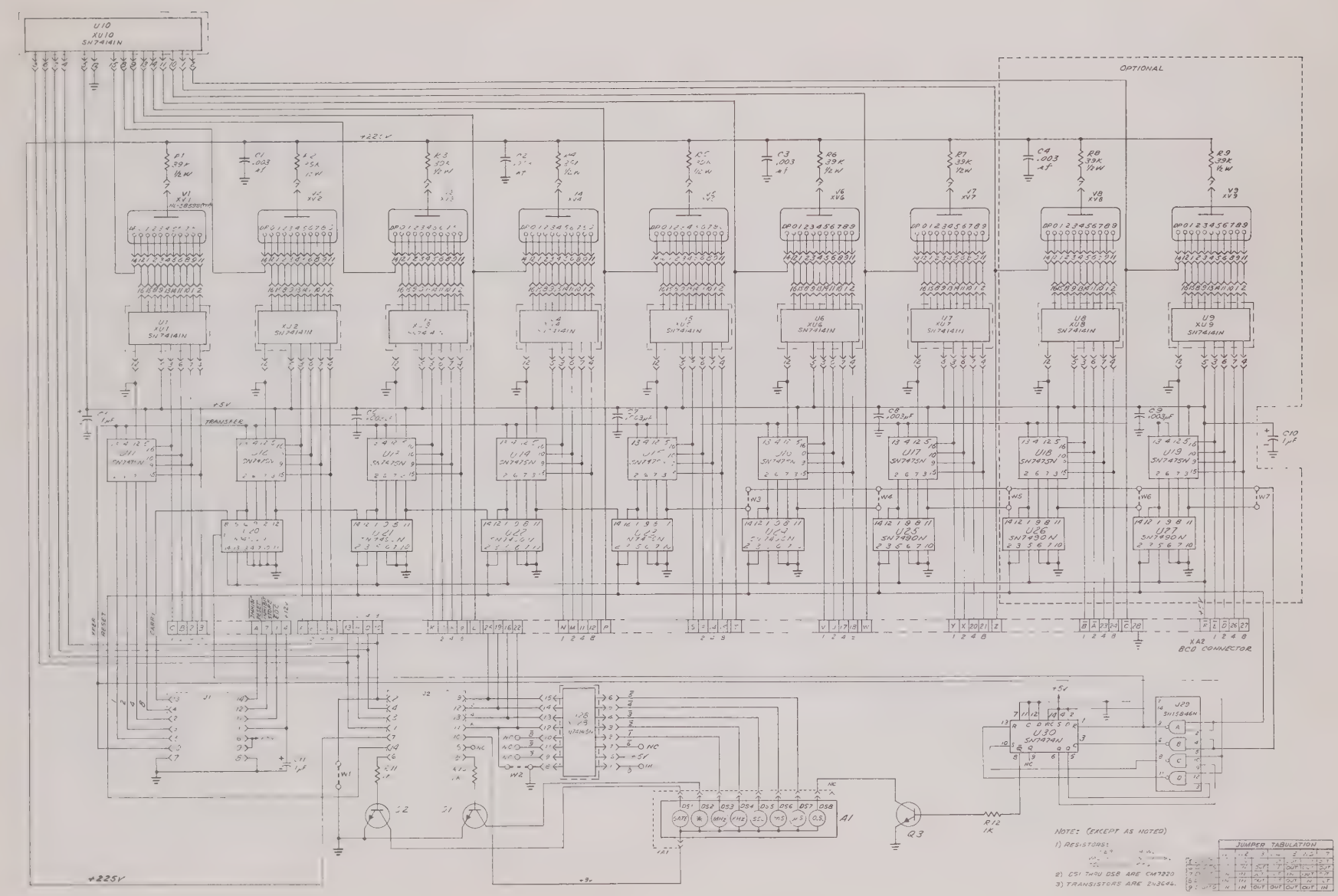
	CHASSIS GROUND	+5V	-5.2V	+12V	-12V
A15	1 THRU 13, 21, 24, 25 A THRU E, H THRU P, CC, Y	S, 15	R, 14	18, V	W, 19
A16	9 THRU 12 N, P, CC, 25	S, 14	Y, 21	T, 16	15
A17					
A18	4 THRU 10, 25 F THRU L	R, 14		T, 16	S, 15
A19	4 THRU 10, 25 F THRU L	R, 14		T, 16	S, 15
A20	GND	+5	-5	+12	-12
A1A2	28	FF		4	

MODEL 6153-50

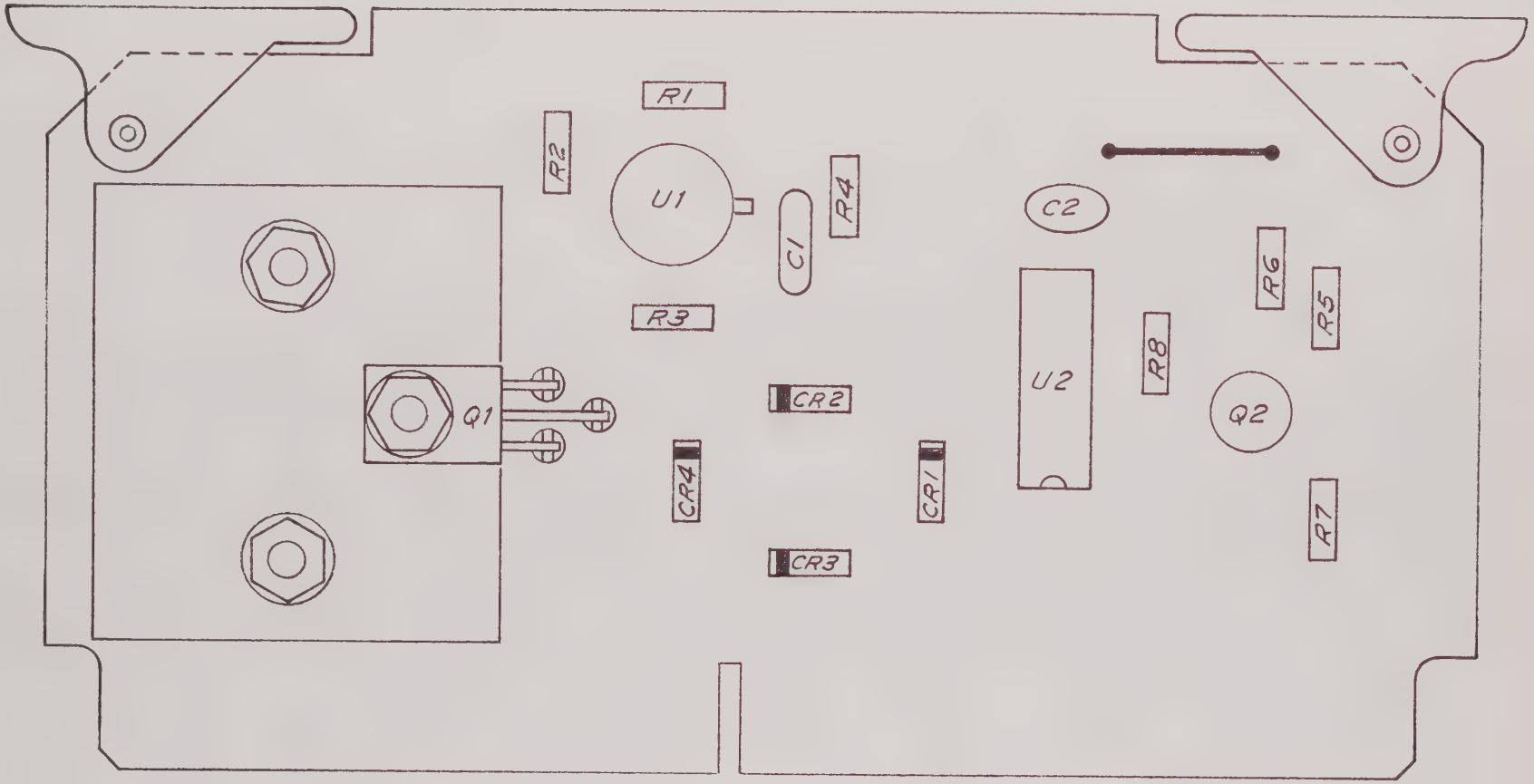
BLOCK DIAGRAM #E39384F



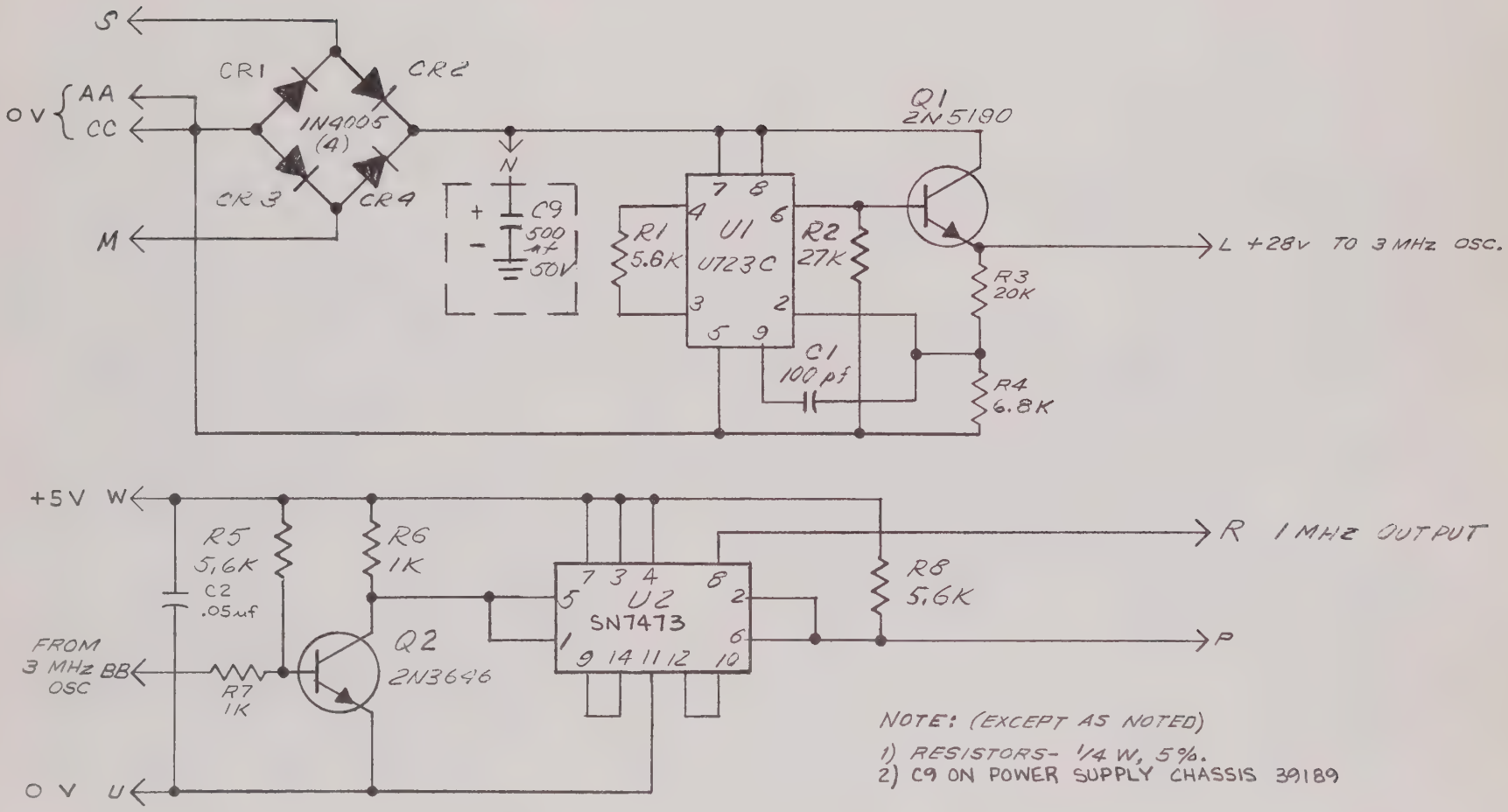
A1, READOUT P.C. ASSEMBLY #C39383D



A1, READOUT SCHEMATIC #E39380D



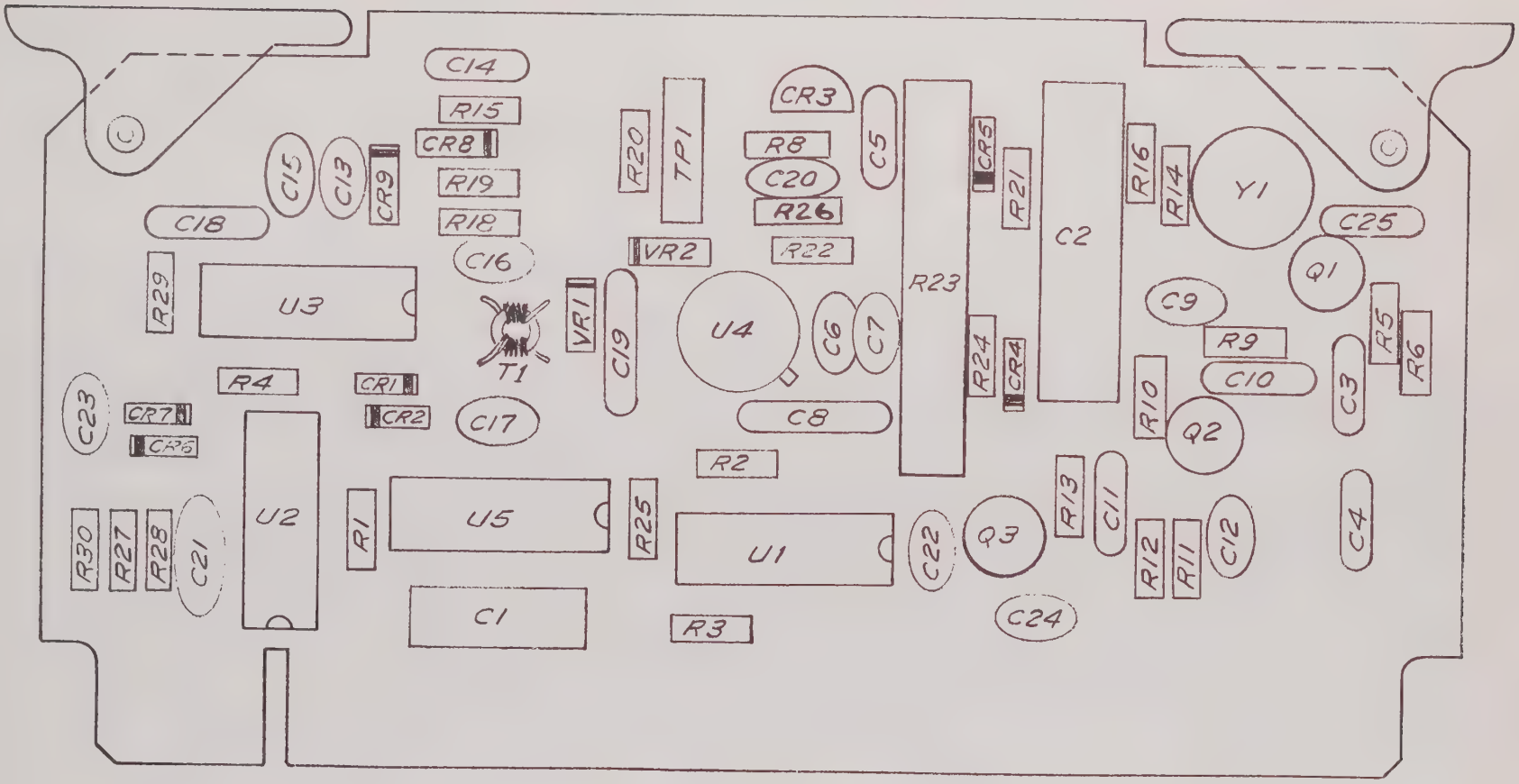
A2, 3 MHz OSCILLATOR POWER P.C. ASSEMBLY #B39367C



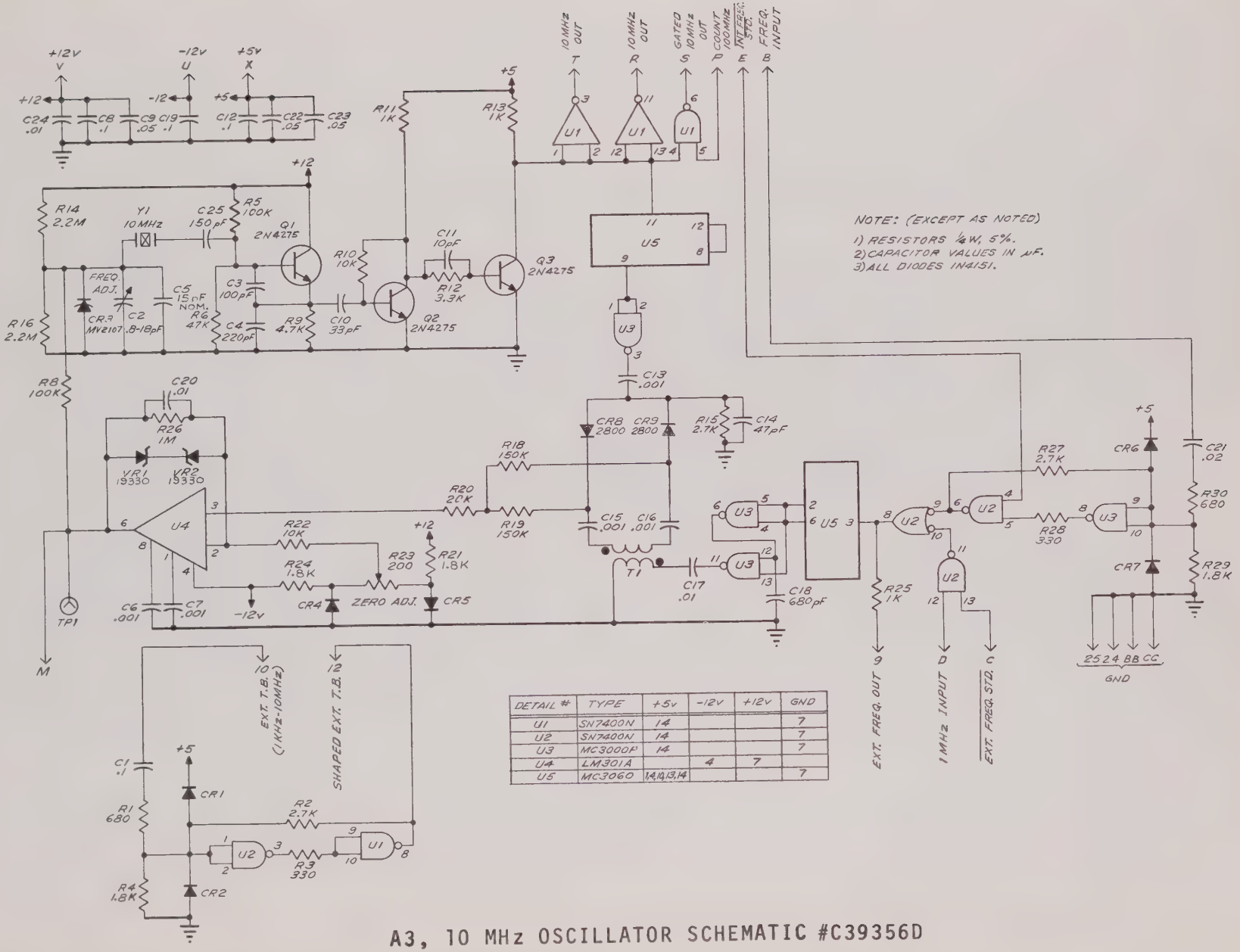
NOTE: (EXCEPT AS NOTED)

1) RESISTORS- 1/4 W, 5%.
2) C9 ON POWER SUPPLY CHASSIS 39189

A2, 3 MHz OSCILLATOR POWER SCHEMATIC #B39364C

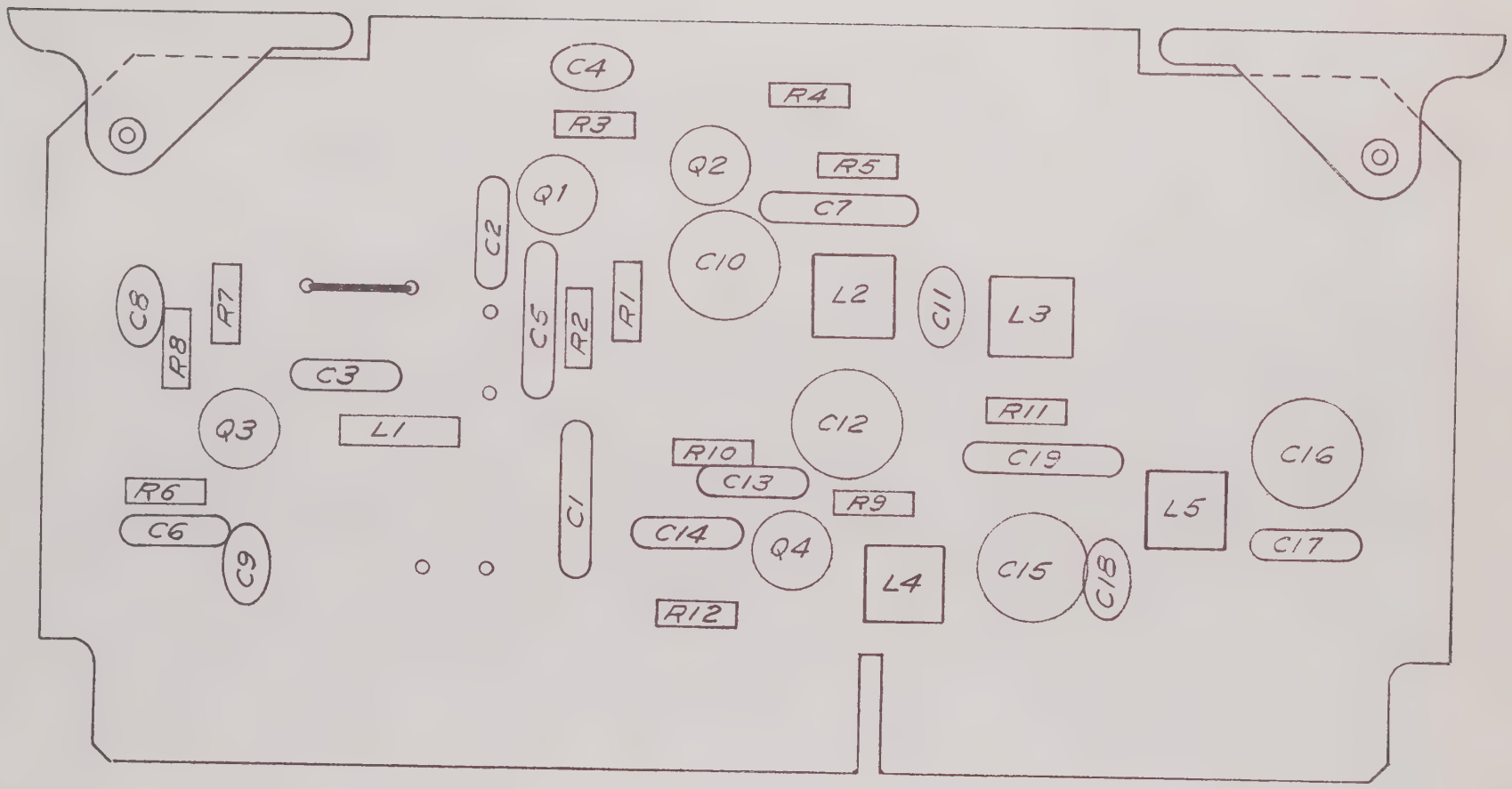


A3, 10 MHz OSCILLATOR P.C. ASSEMBLY #B39359G

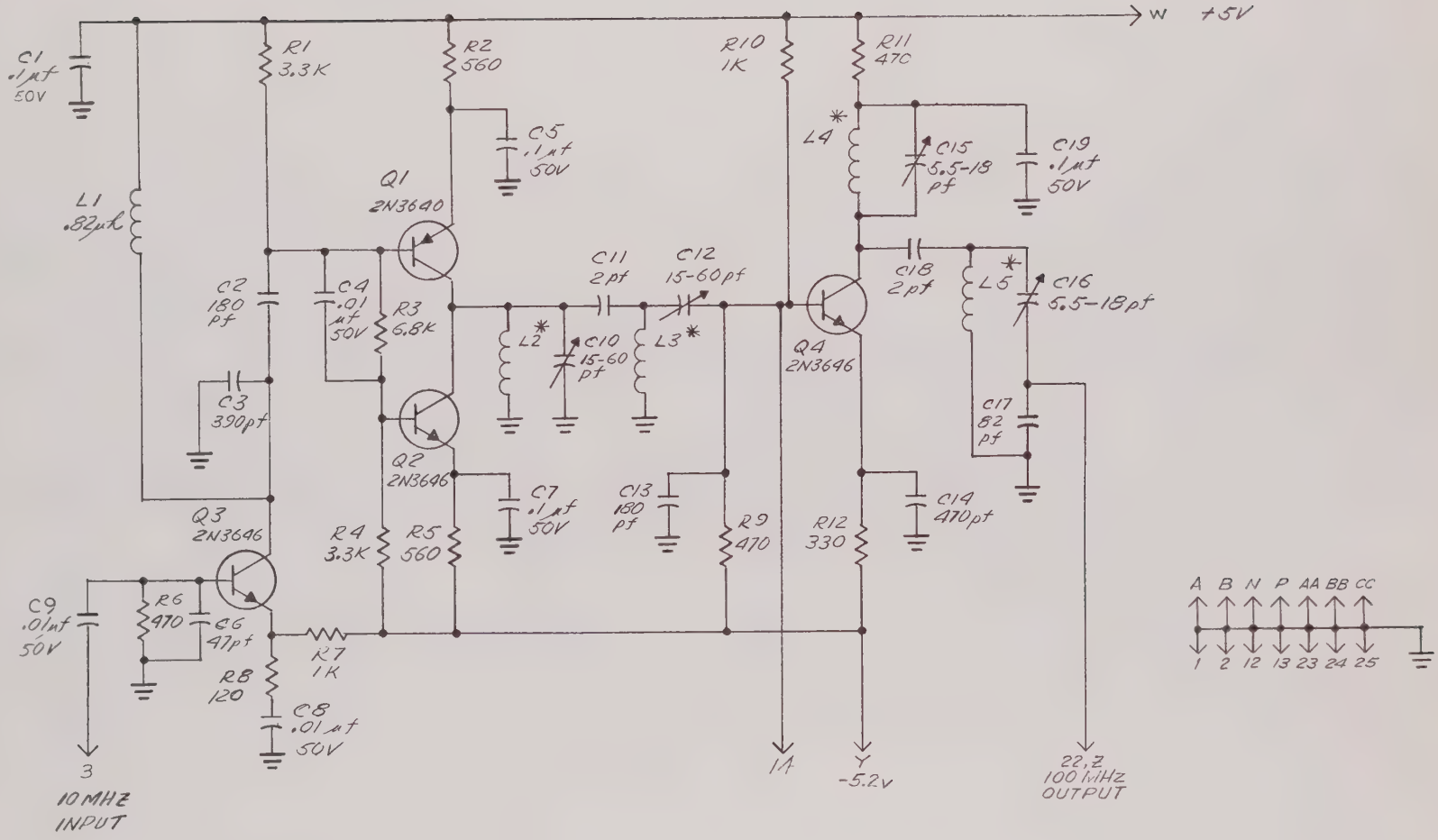


DETAIL #	TYPE	+5v	-12V	+12V	GND
U1	SN7400N	14			7
U2	SN7400N	14			7
U3	MC3000P	14			7
U4	LM301A		4	7	
U5	MC3060	1,4,10,13,14			7

A3, 10 MHz OSCILLATOR SCHEMATIC #C39356D

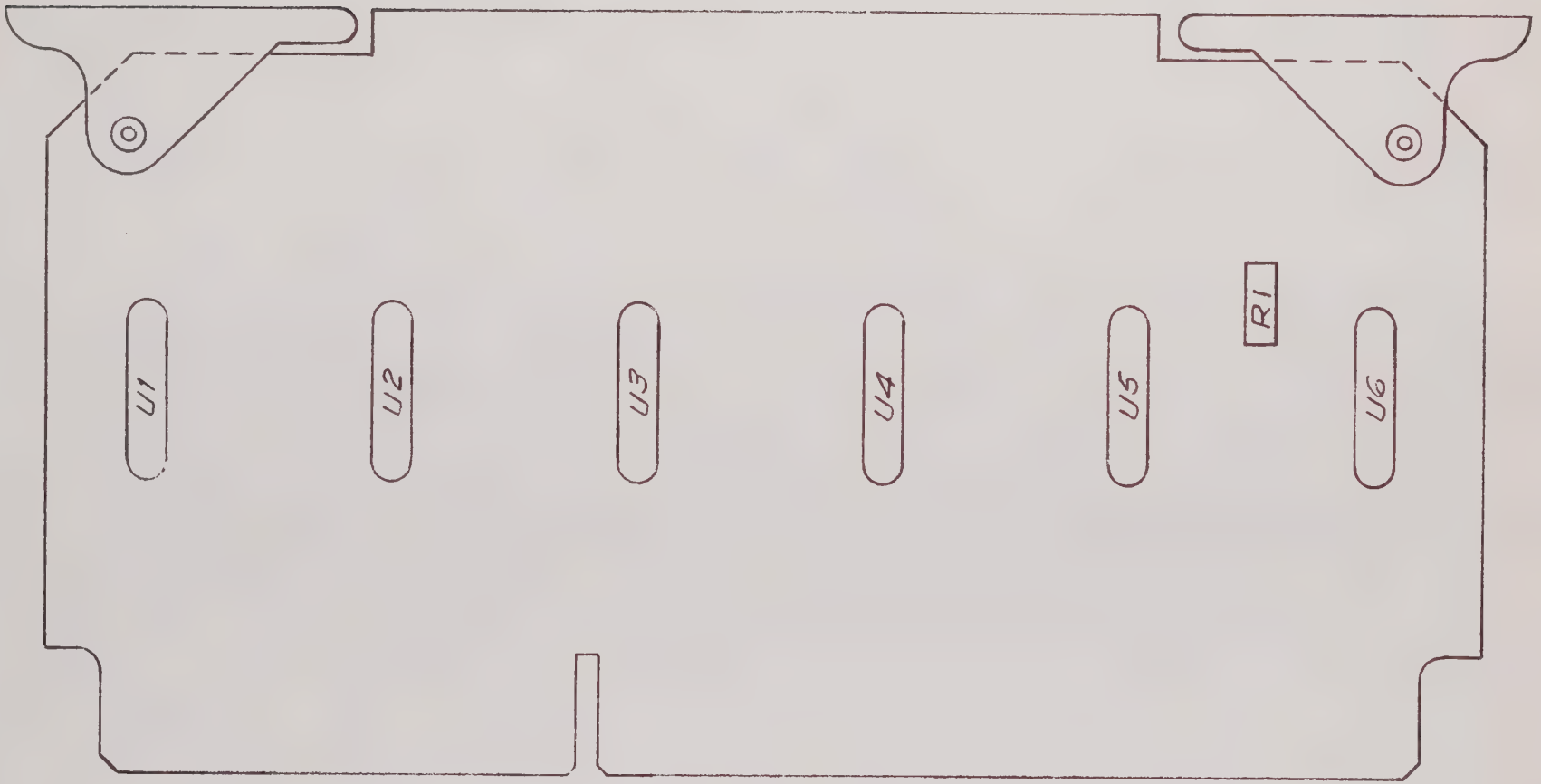


A4, 100 MHz MULTIPLIER P.C. ASSEMBLY #B39363A

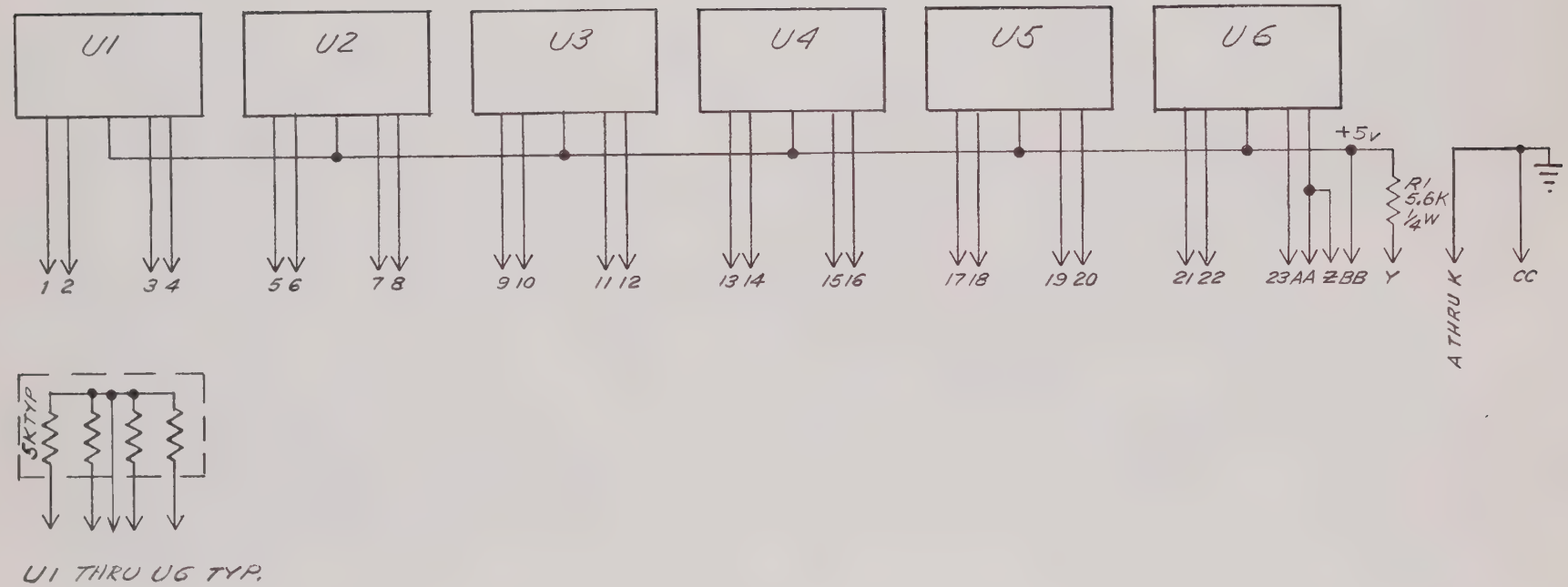


NOTE: UNLESS OTHERWISE NOTED
1.) RESISTORS — 1/4 W, 5%
2.) * INDUCTORS ARE CUSTOM — L2, L3, L4 & L5

A4, 100 MHz MULTIPLIER SCHEMATIC #C39360B

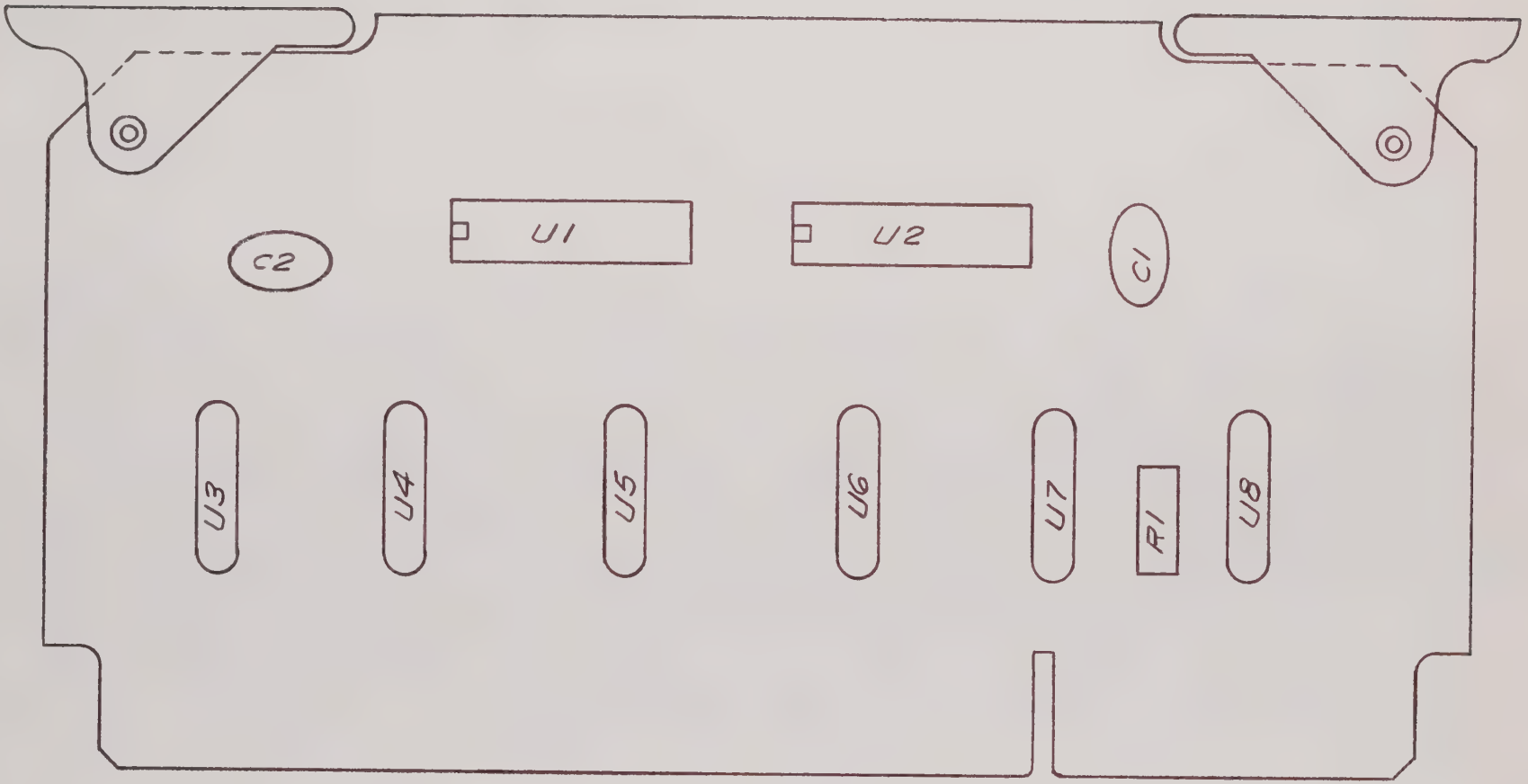


A6, ATTENUATOR SELECT P.C. ASSEMBLY #B39355A

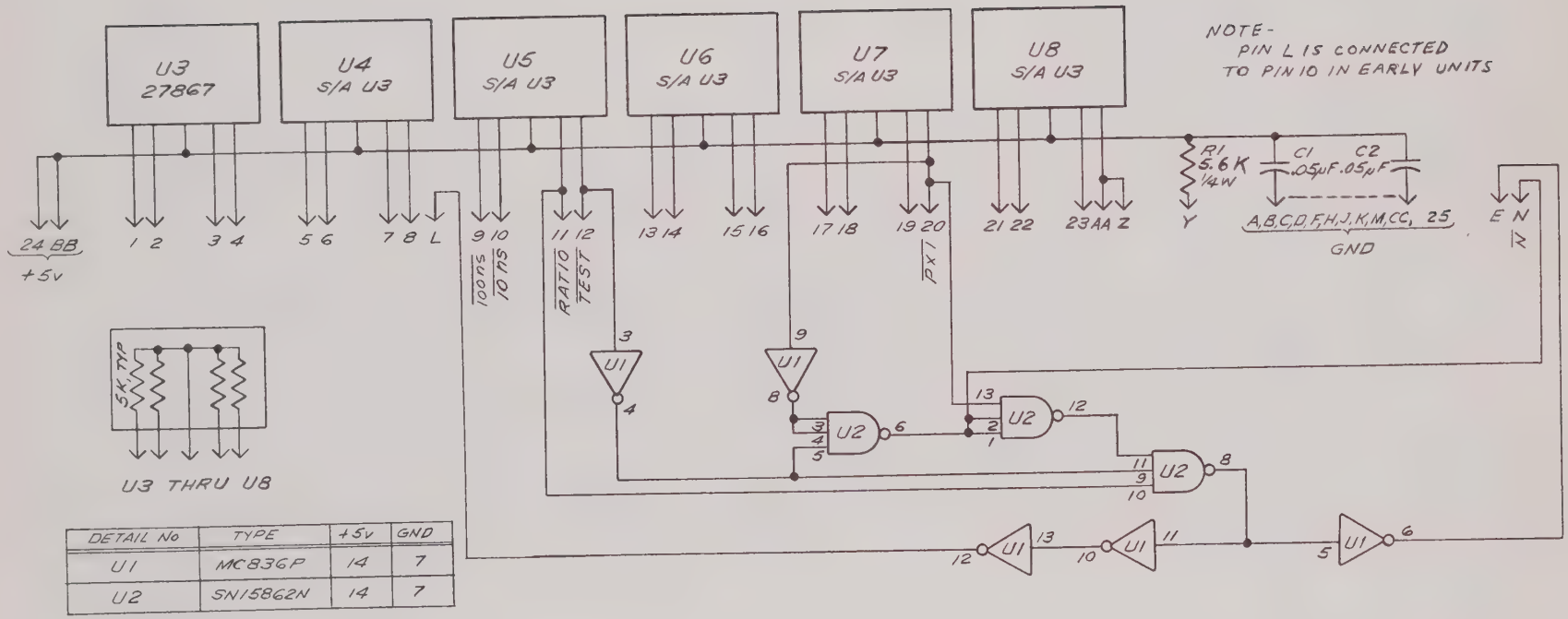


U1 THRU U6 TYP.

A6, ATTENUATOR SELECT SCHEMATIC #B39352C

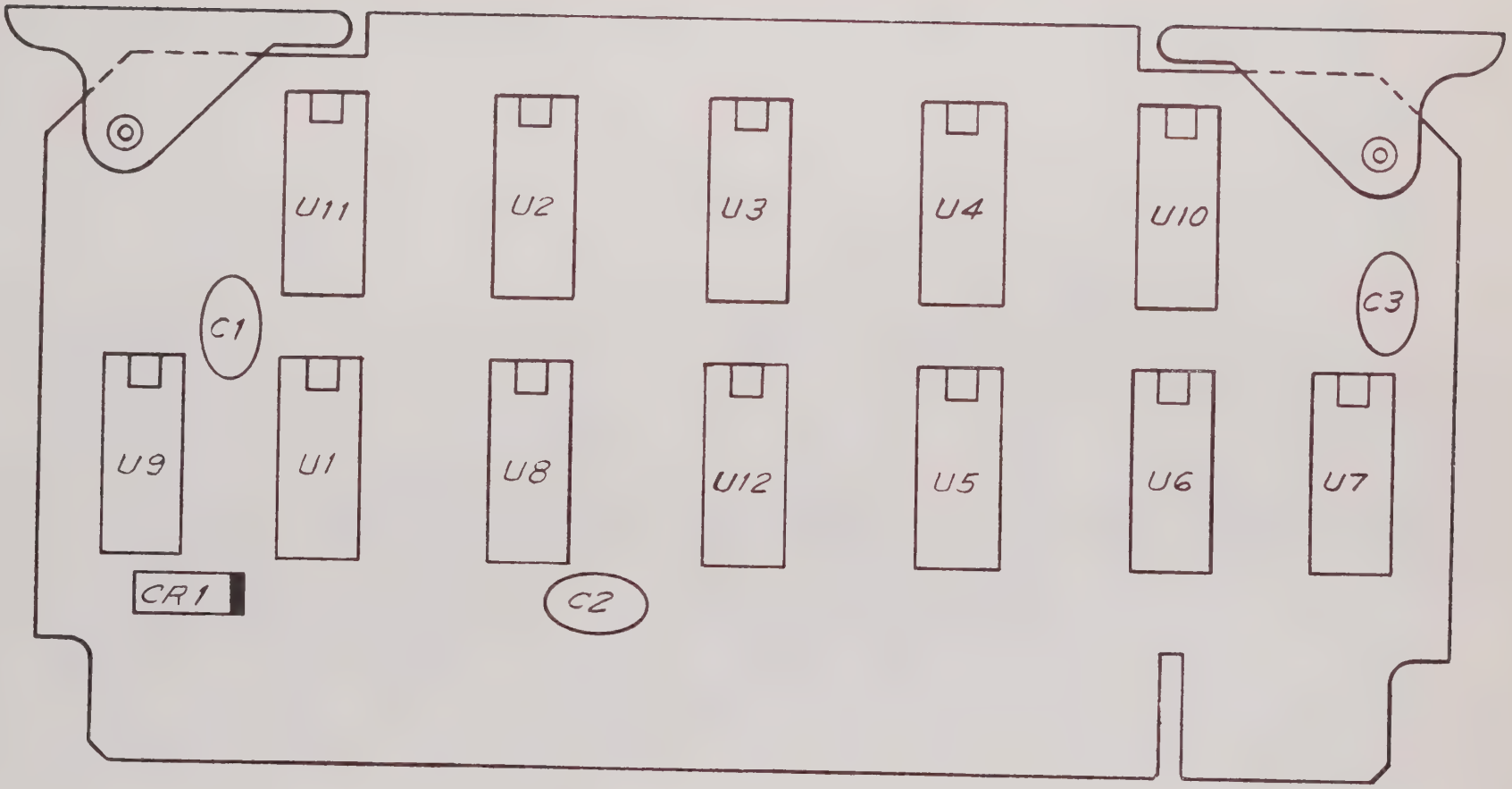


A7, FUNCTION SELECT P.C. ASSEMBLY #B39803A



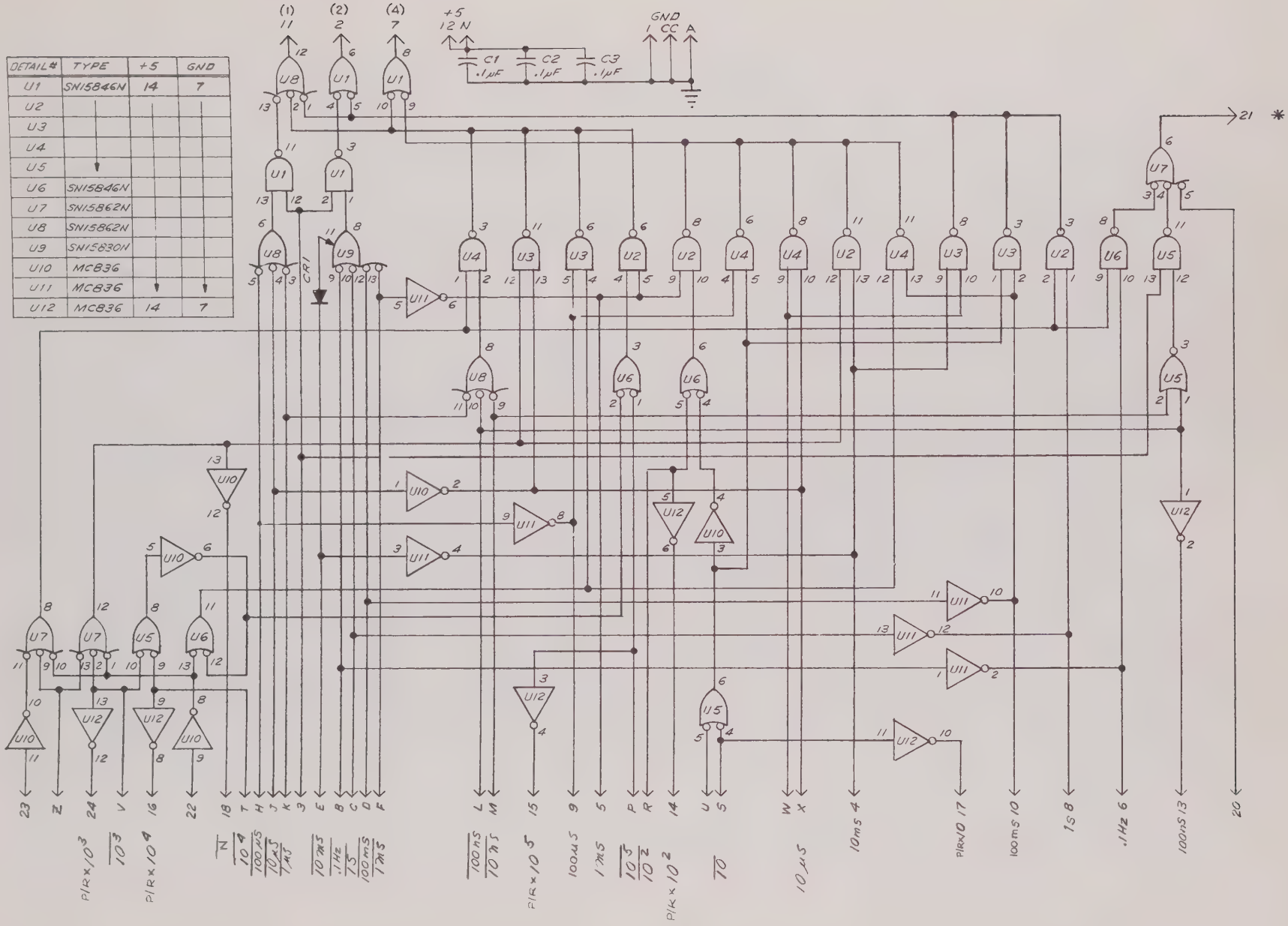
DETAIL No	TYPE	+5v	GND
U1	MC836P	14	7
U2	SN15862N	14	7

A7, FUNCTION SELECT SCHEMATIC #B39800C

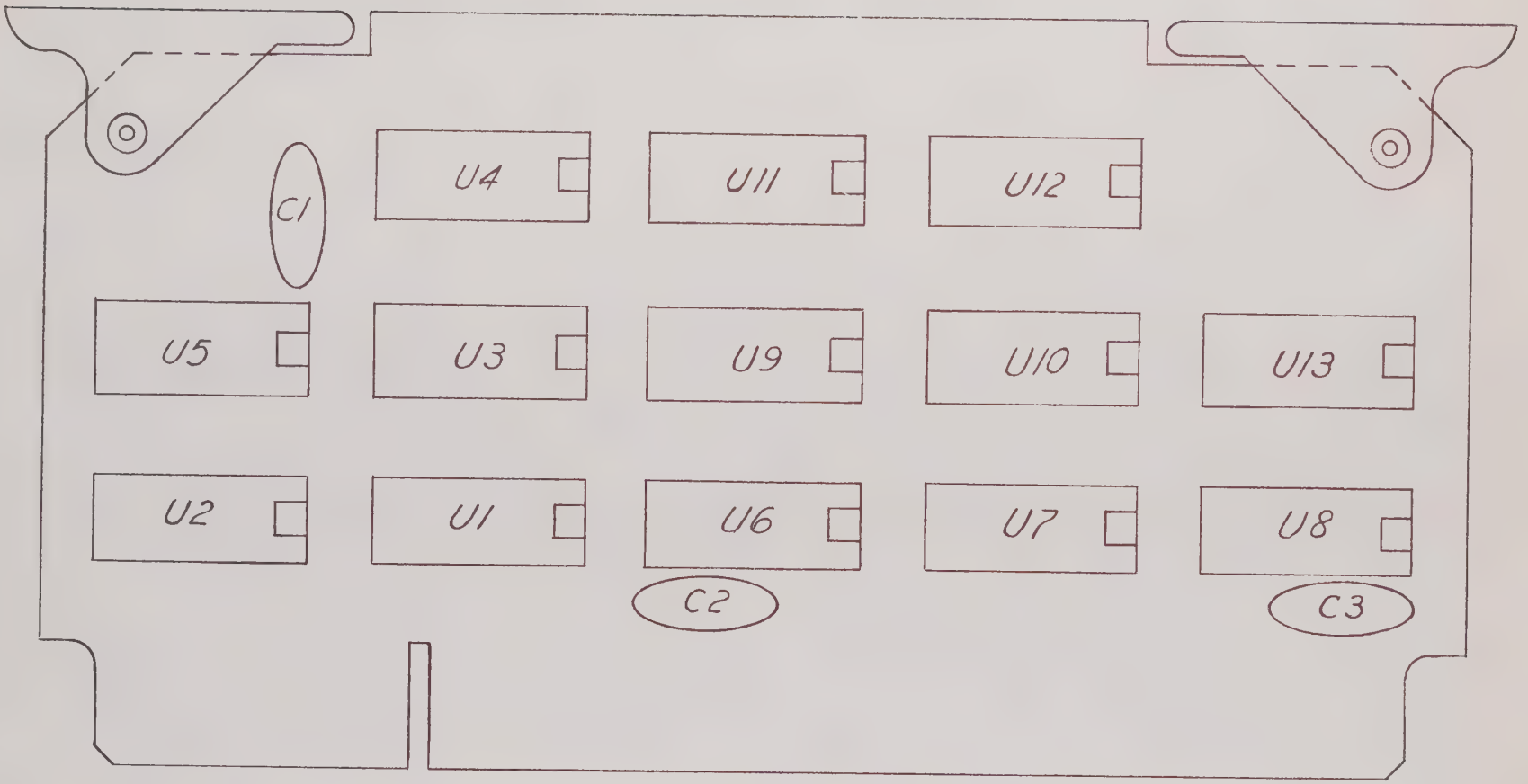


A8, LEGEND LOGIC P.C. ASSEMBLY #B39335A

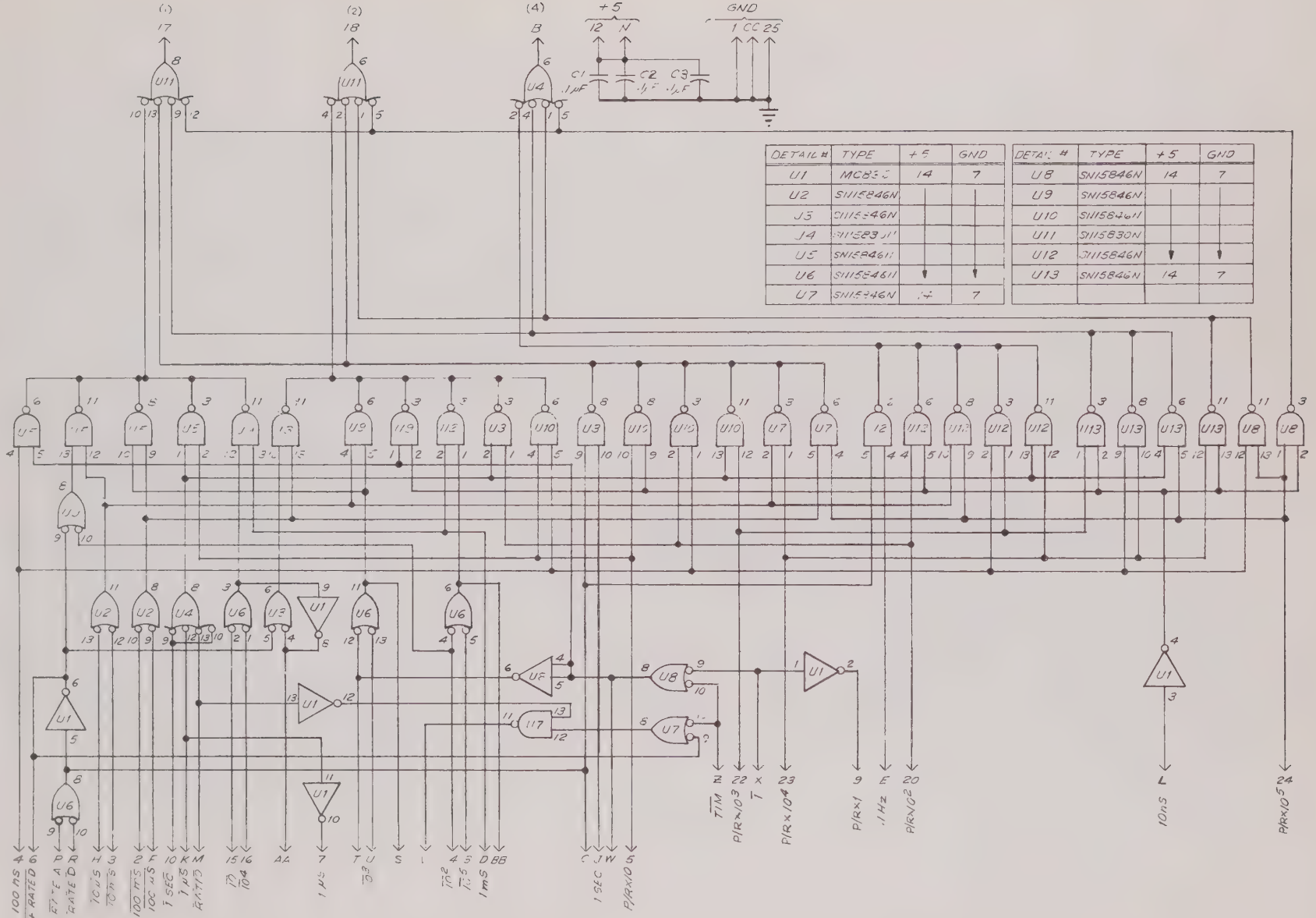
DETAIL #	TYPE	+5	GND
U1	SN15846N	14	7
U2			
U3			
U4			
U5			
U6	SN15846N		
U7	SN15862N		
U8	SN15862N		
U9	SN15830N		
U10	MC836		
U11	MC836		
U12	MC836	14	7



A8, LEGEND LOGIC SCHEMATIC #C39332A



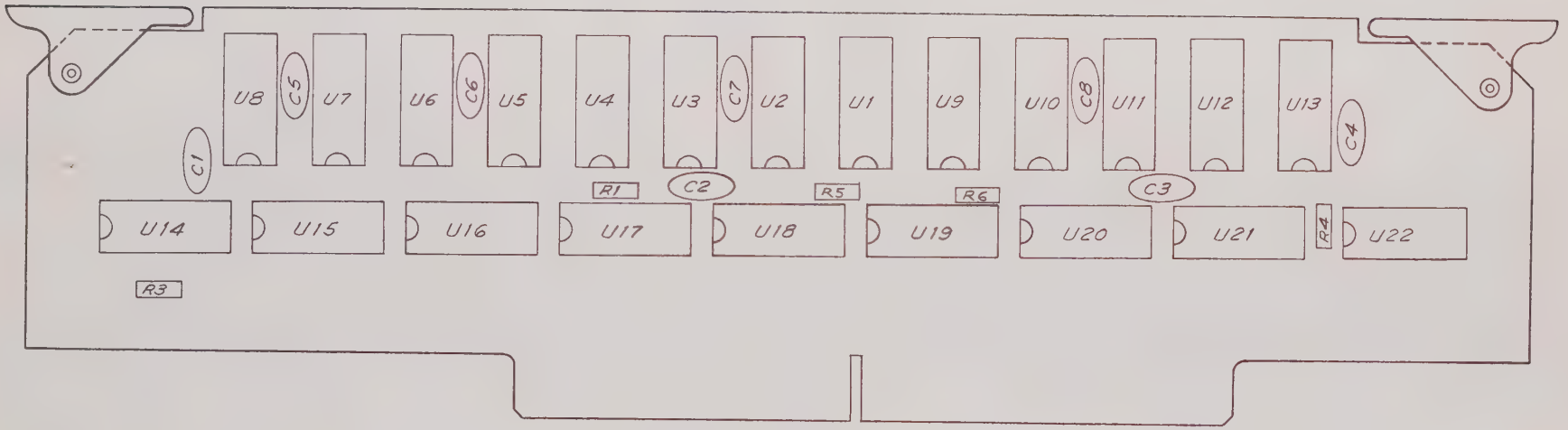
A9, DECIMAL LOGIC P.C. ASSEMBLY #B39339A



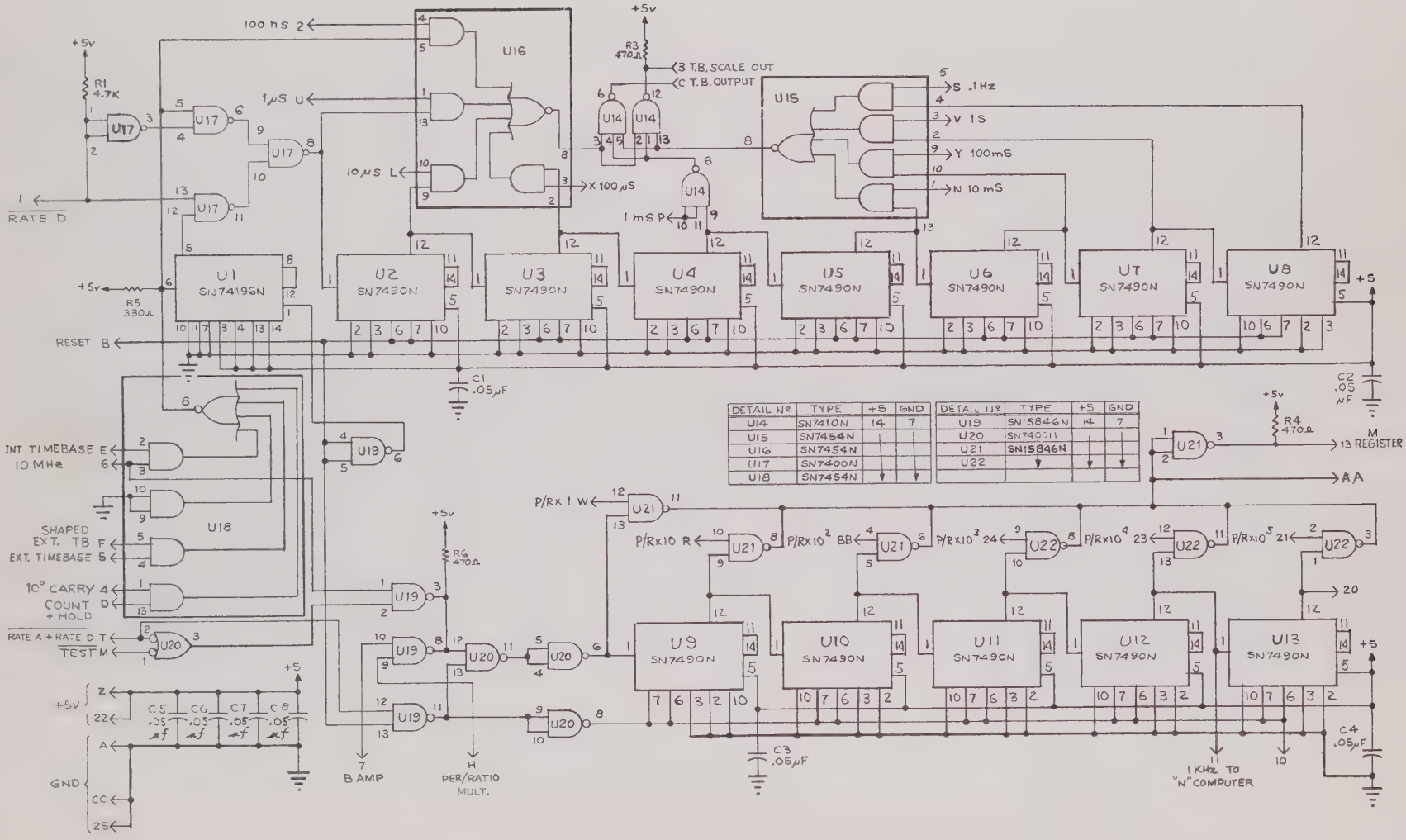
DETAIL #	TYPE	+5	GND
U1	MC830	14	7
U2	SN15846N		
U3	SN15846N		
U4	SN15830N		
U5	SN15846N		
U6	SN15846N		
U7	SN15846N	14	7

DETAIL #	TYPE	+5	GND
U8	SN15846N	14	7
U9	SN15846N		
U10	SN15846N		
U11	SN15830N		
U12	SN15846N		
U13	SN15846N	14	7

A9, DECIMAL LOGIC SCHEMATIC #C39336A



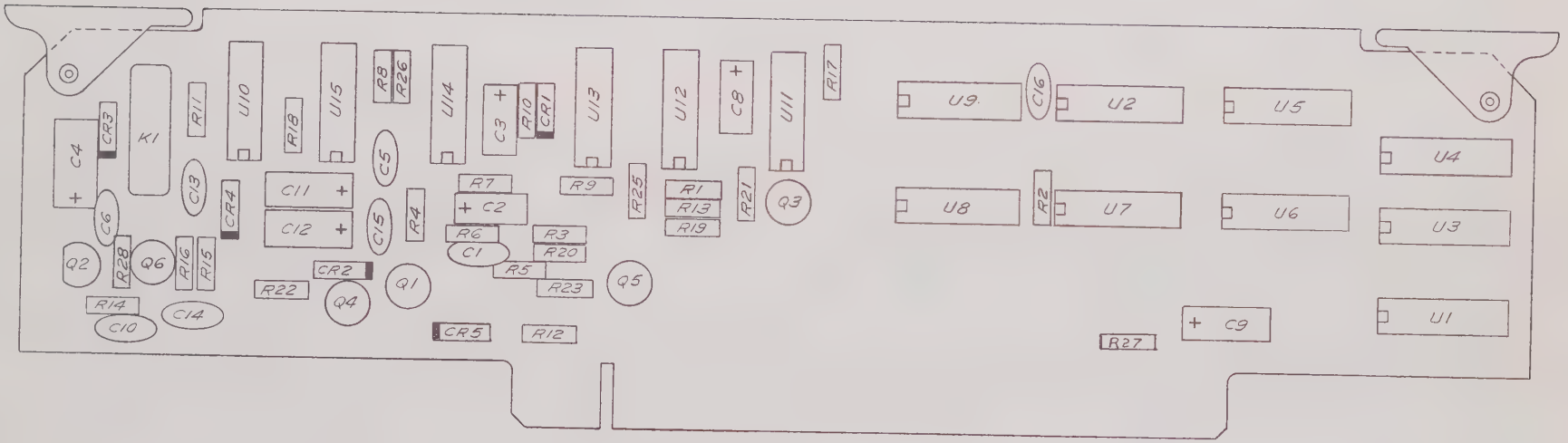
A10, TIME BASE P.C. ASSEMBLY #C39347C



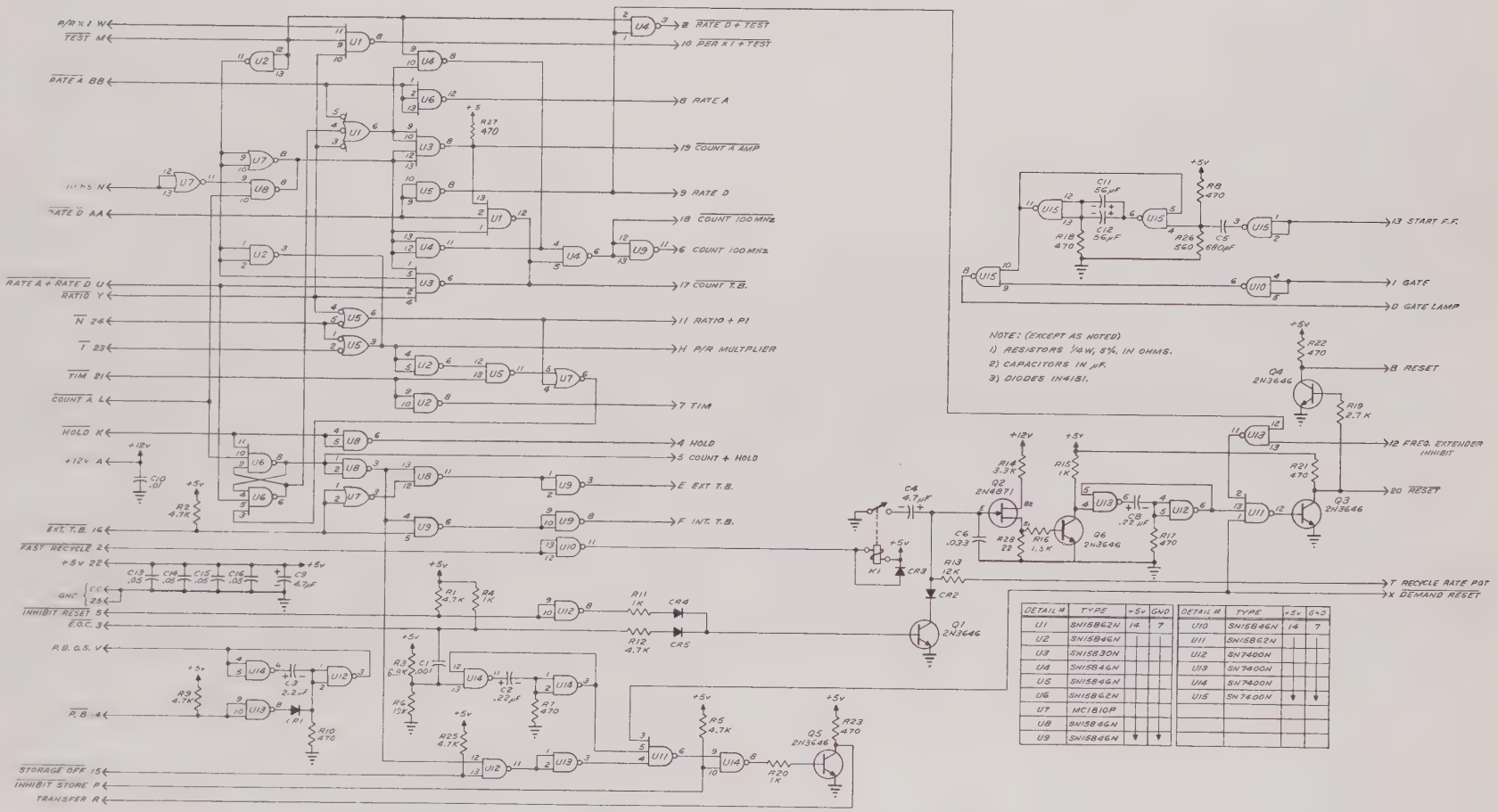
DETAIL Nº	TYPE	+5	GND
U14	SN7410N	14	7
U15	SN7454N		
U16	SN7454N		
U17	SN7400N		
U18	SN7454N		

DETAIL Nº	TYPE	+5	GND
U19	SN15846N	14	7
U20	SN74011		
U21	SN15846N		
U22			

A10, TIME BASE SCHEMATIC #C39344C



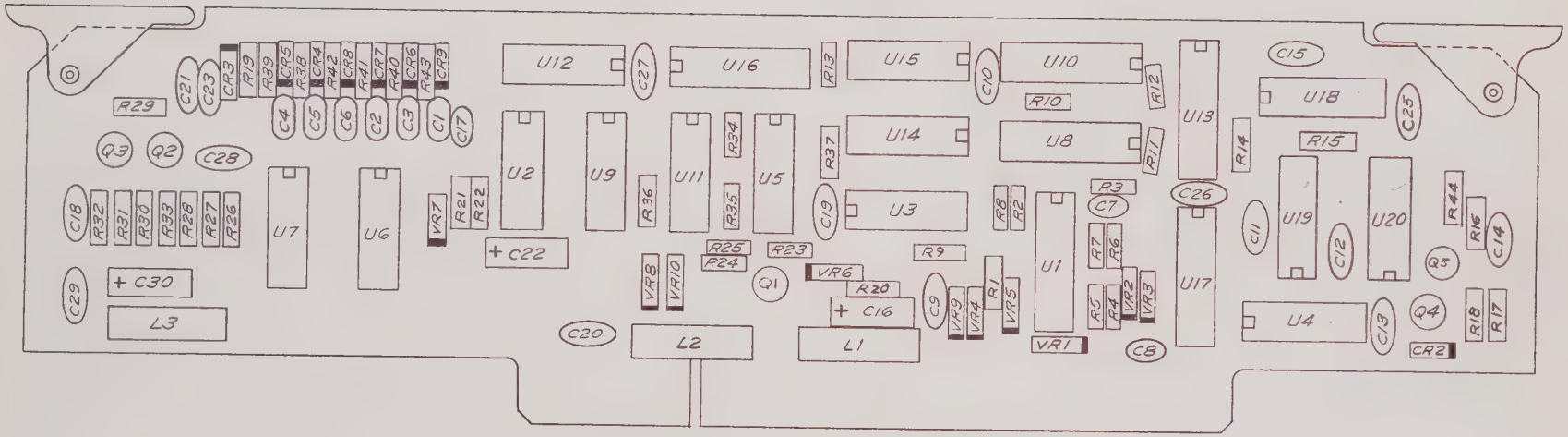
A11, FUNCTION CONTROL P.C. ASSEMBLY #C39343G



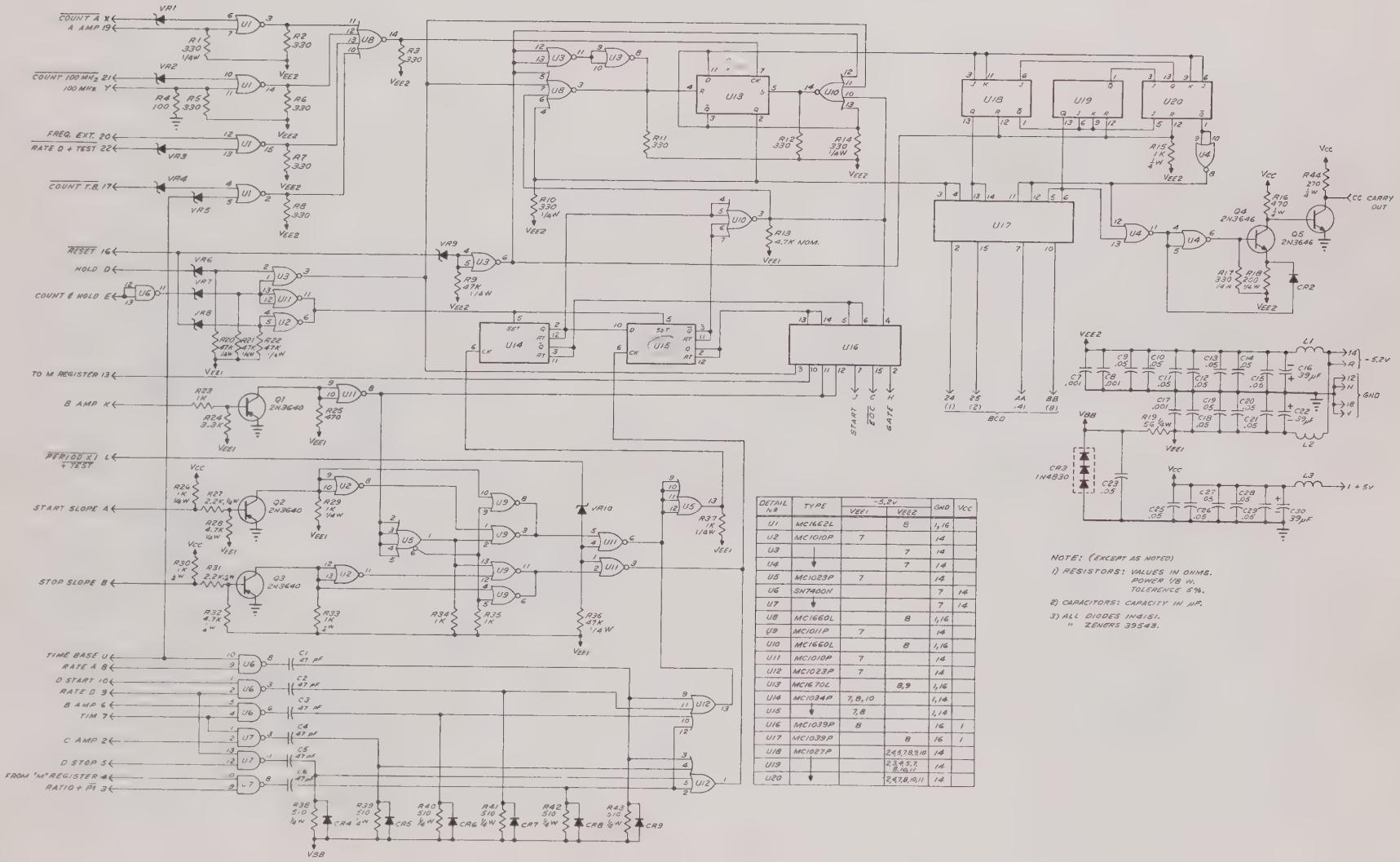
DETAIL #	TYPE	+5V	GND
U1	SN15862N	14	7
U2	SN15842N		
U3	SN15830N		
U4	SN15842N		
U5	SN15842N		
U6	SN15862N		
U7	MC1810P		
U8	SN15842N		
U9	SN15842N		

DETAIL #	TYPE	+5V	GND
U10	SN15846N	14	7
U11	SN15842N		
U12	SN7400N		
U13	SN7400N		
U14	SN7400N		
U15	SN7400N		

A11, FUNCTION CONTROL SCHEMATIC #D39340G

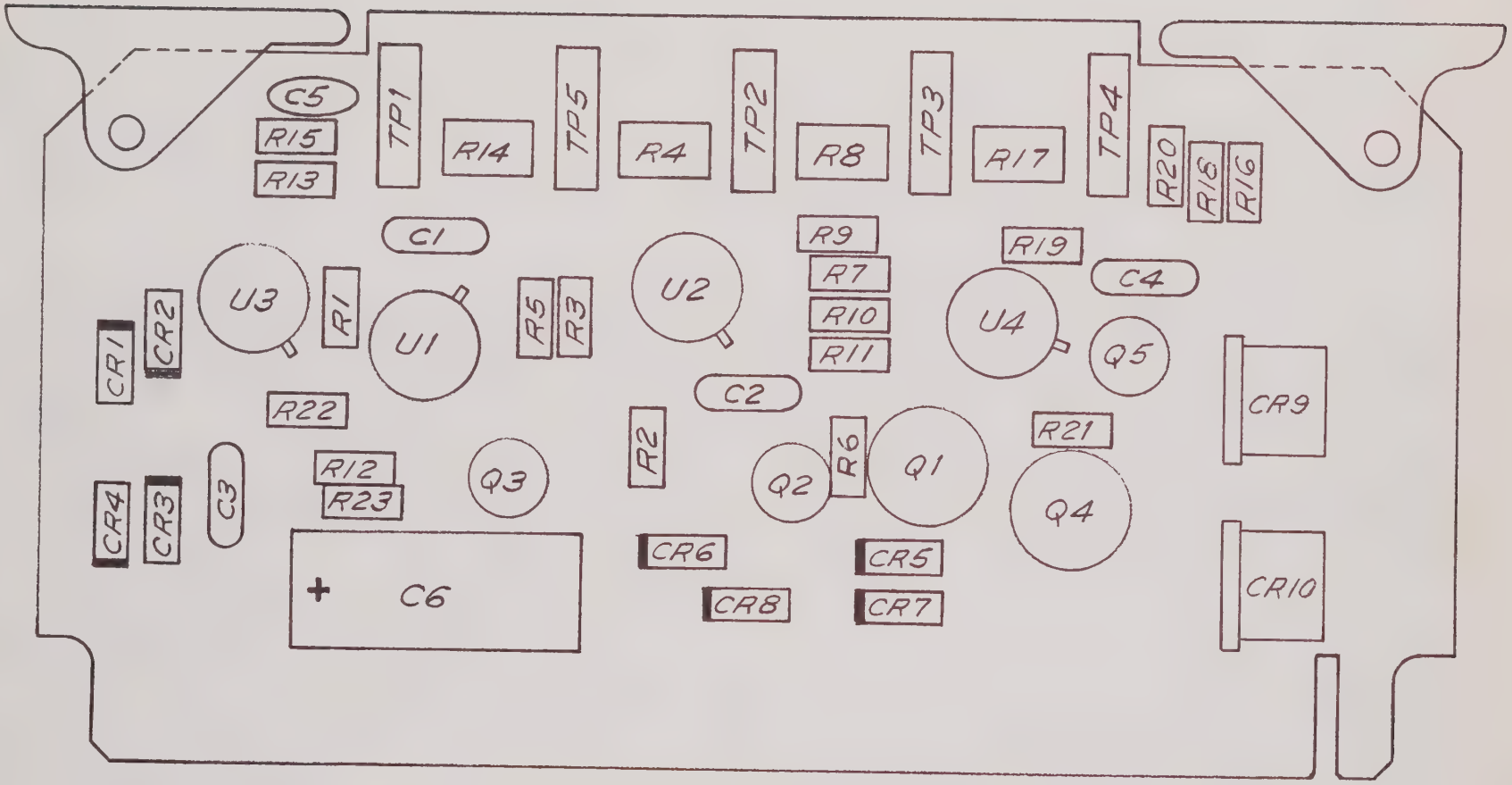


A12, 200 MHz DECADE & GATE P.C. ASSEMBLY #C39327C

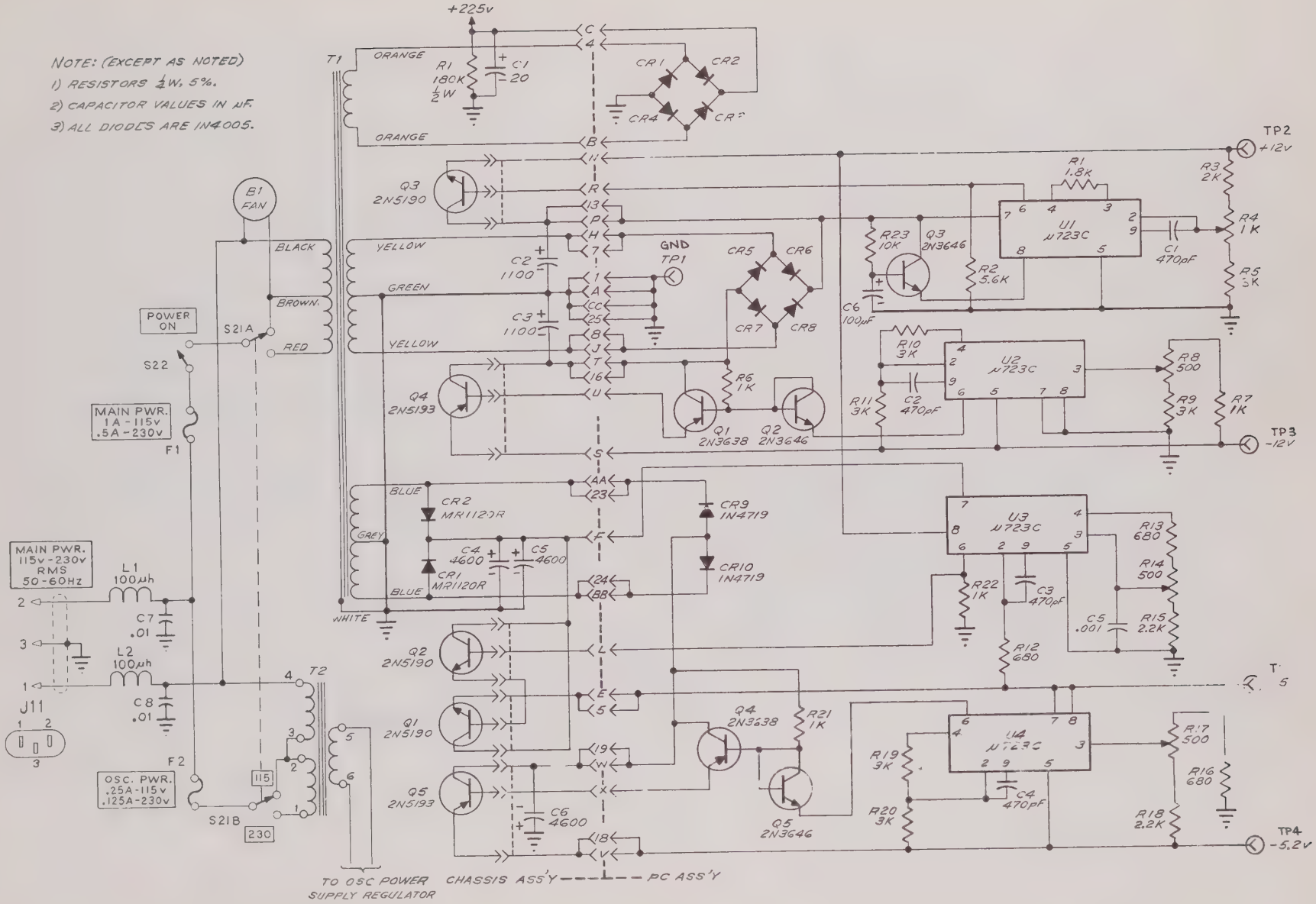


DETAIL N.#	TYPE	-5.2V VEE1	-5.2V VEE2	GND	Vcc
U1	MC1662L		8	1,16	
U2	MC1010P	7		14	
U3	↓		7	14	
U4			7	14	
U5	MC1023P	7		14	
U6	SN7400N			7	14
U7	↓			7	14
U8	MC1660L		8	1,16	
U9	MC1011P	7		14	
U10	MC1660L		8	1,16	
U11	MC1010P	7		14	
U12	MC1023P	7		14	
U13	MC1670L		8,9	1,16	
U14	MC1034P	7,8,10		1,14	
U15	↓	7,8		1,14	
U16	MC1039P	8		16	1
U17	MC1039P		8	16	1
U18	MC1027P		2,4,5,7,8,9,10	14	
U19	↓		2,3,4,5,7,8,9,11	14	
U20	↓		2,4,7,8,10,11	14	

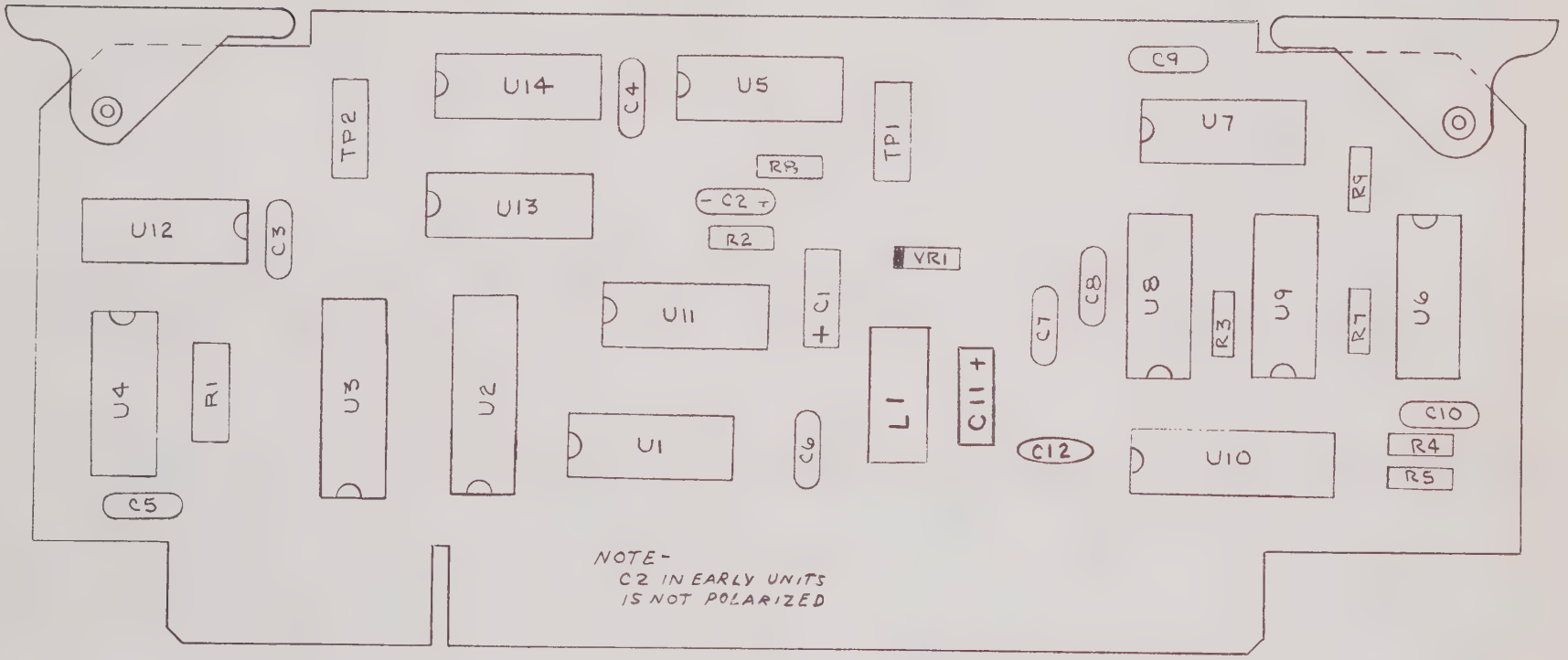
A12, 200 MHz DECADE & GATE SCHEMATIC #D39324C



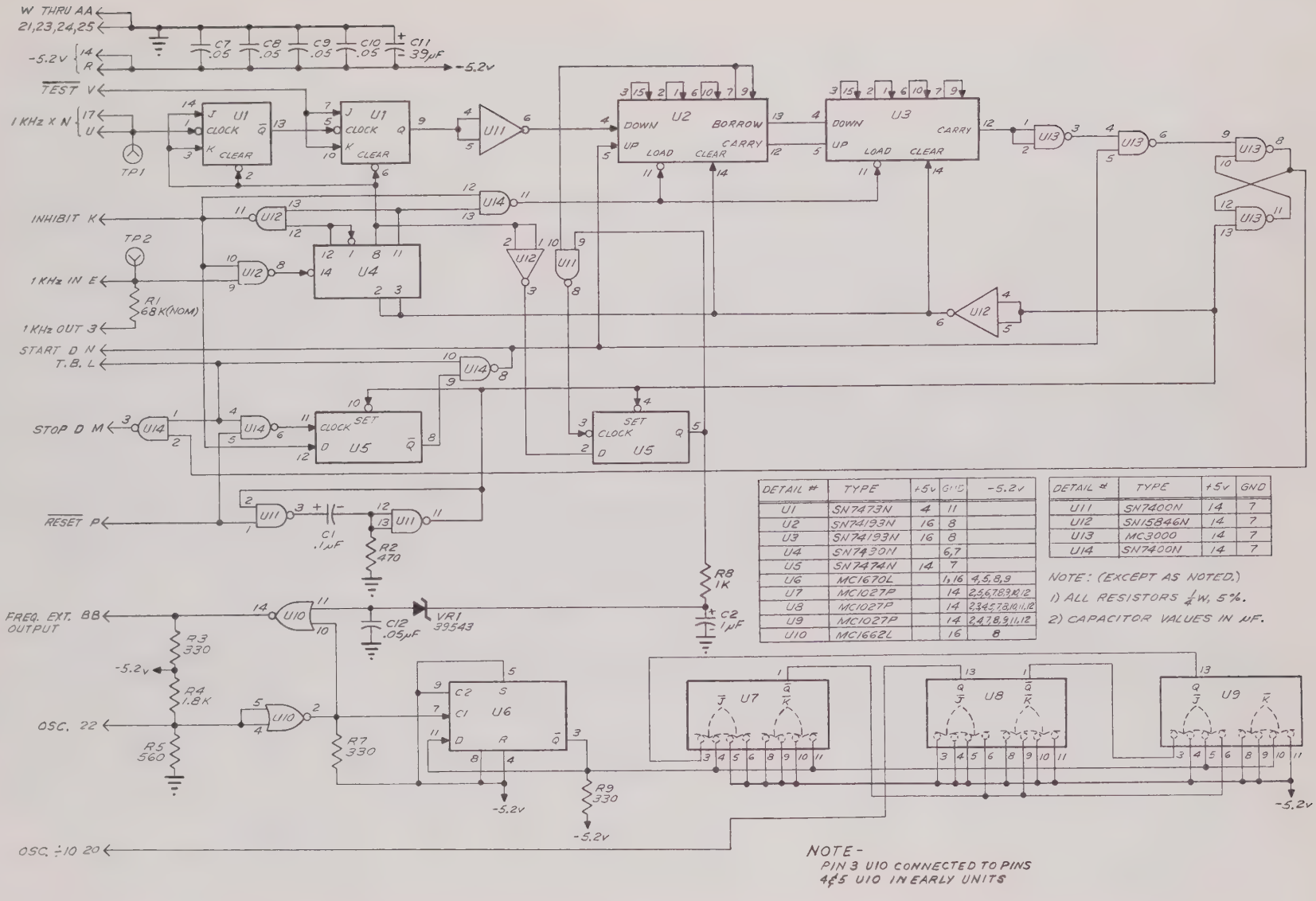
A13, MAIN POWER P.C. ASSEMBLY #B39351A



A13, MAIN POWER SCHEMATIC #C39348D



A14, "N" COMPUTER P.C. ASSEMBLY #B39375C



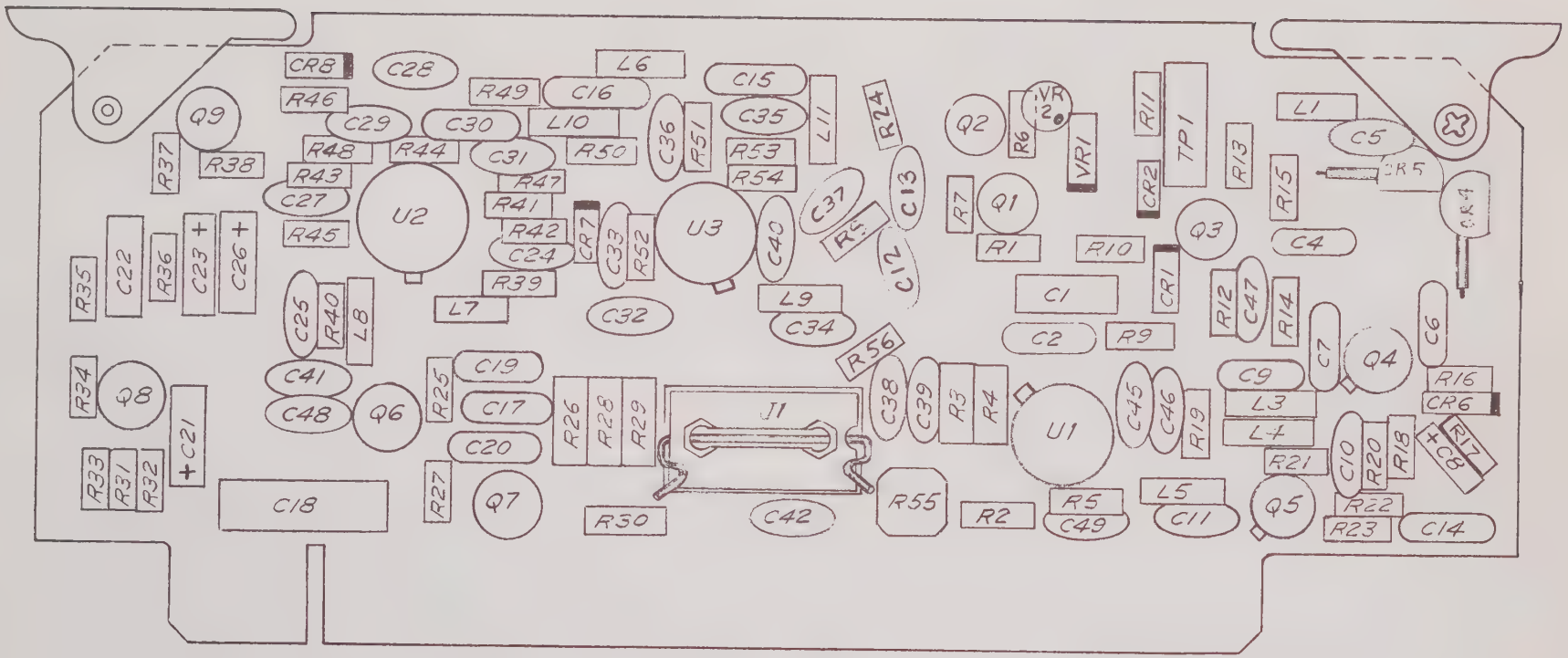
DETAIL #	TYPE	+5V	GND	-5.2V
U1	SN7473N	4	11	
U2	SN74193N	16	8	
U3	SN74193N	16	8	
U4	SN7430N		6,7	
U5	SN7474N	14	7	
U6	MC1670L		1,16	4,5,8,9
U7	MC1027P		14	2,5,6,7,8,9,K,12
U8	MC1027P		14	2,3,4,7,8,10,11,12
U9	MC1027P		14	2,4,7,8,9,11,12
U10	MC1662L		16	8

DETAIL #	TYPE	+5V	GND
U11	SN7400N	14	7
U12	SN15846N	14	7
U13	MC3000	14	7
U14	SN7400N	14	7

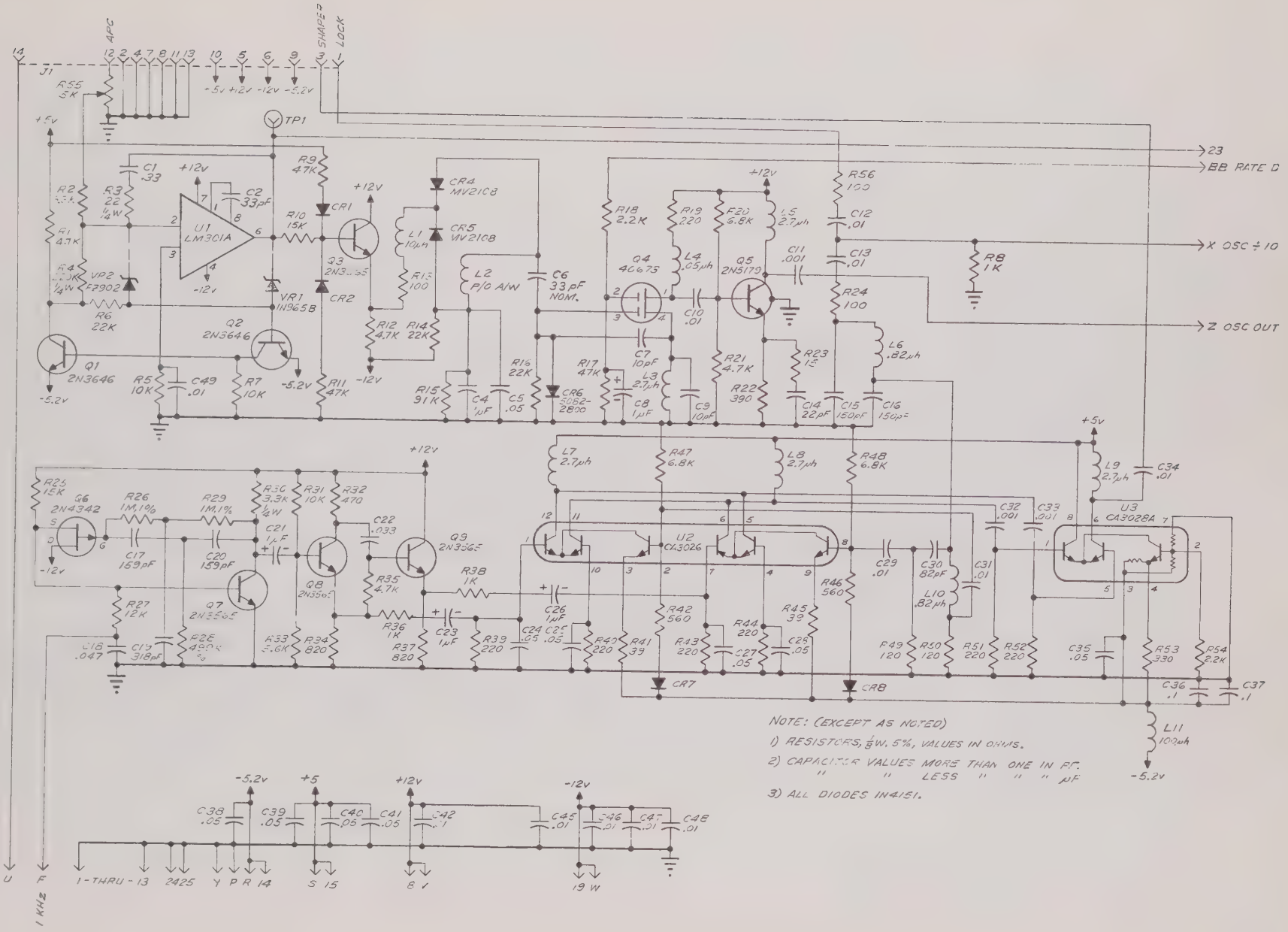
NOTE: (EXCEPT AS NOTED.)
1) ALL RESISTORS ¼W, 5%.
2) CAPACITOR VALUES IN µF.

NOTE-
PIN 3 U10 CONNECTED TO PINS 4&5 U10 IN EARLY UNITS

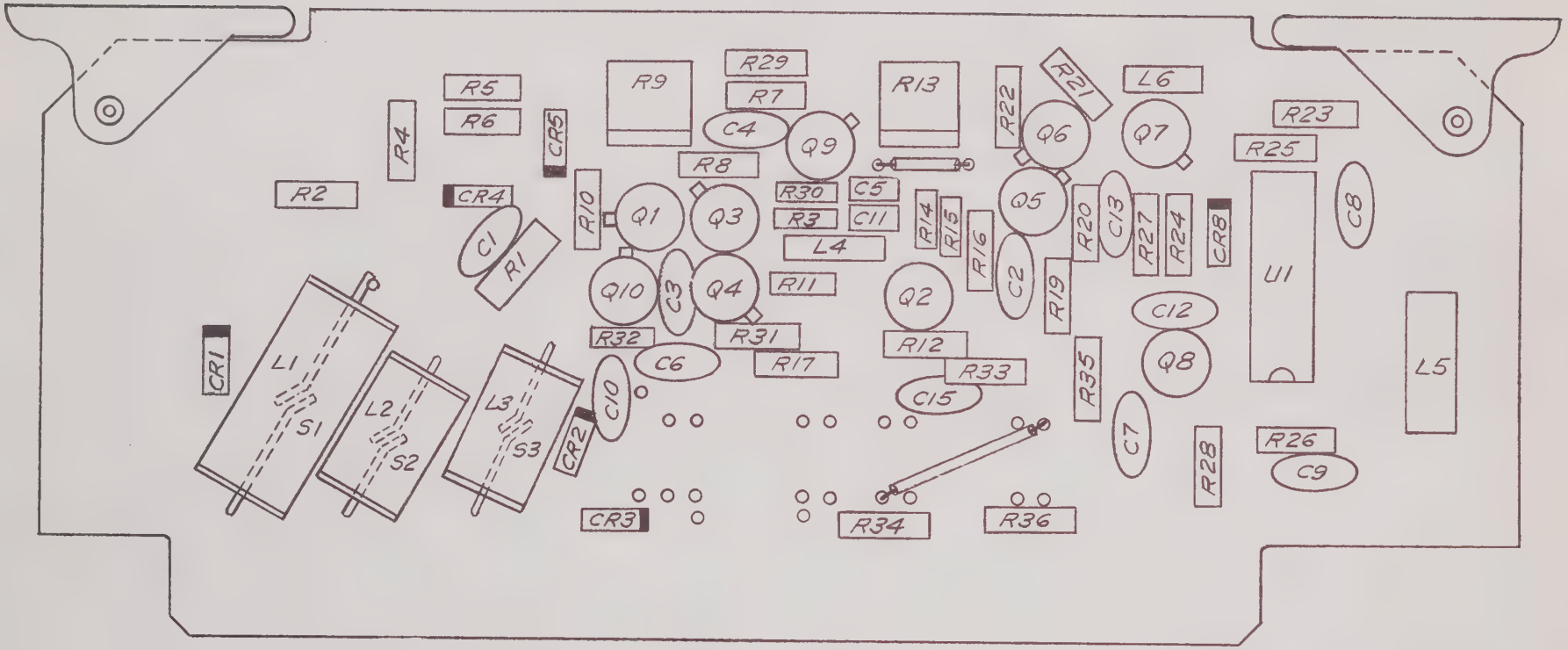
A14, "N" COMPUTER SCHEMATIC #C39372C



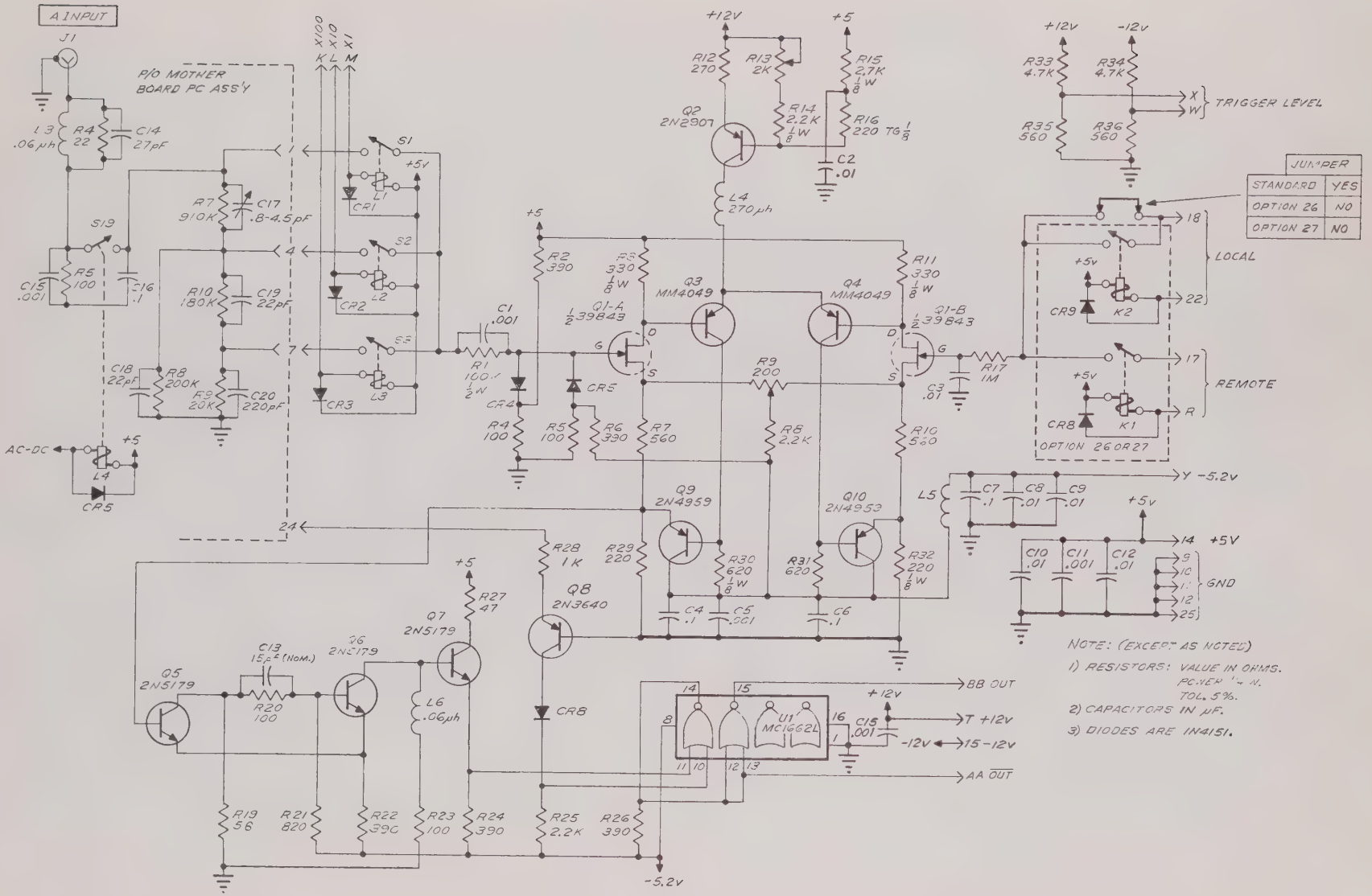
A15, SHIFTER P.C. ASSEMBLY #C39371G



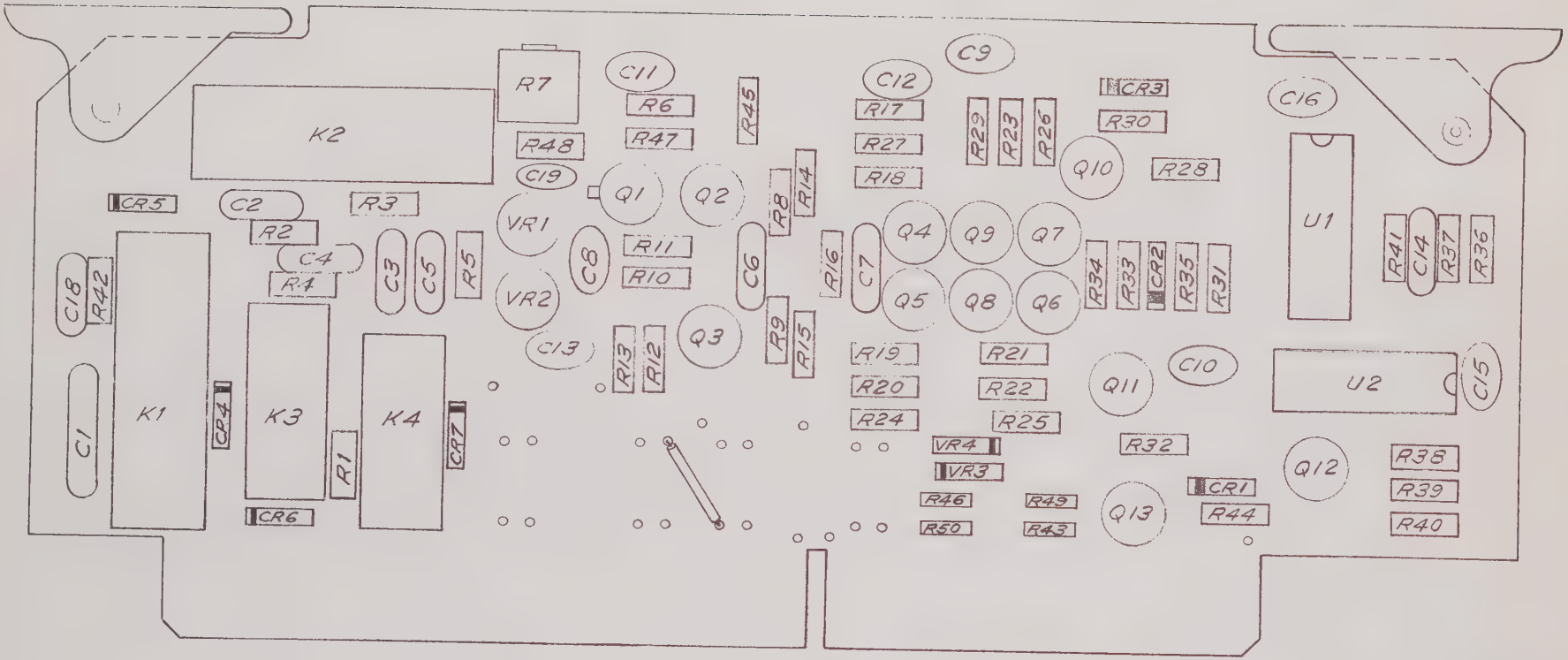
A15, SHIFTER SCHEMATIC #C39368G



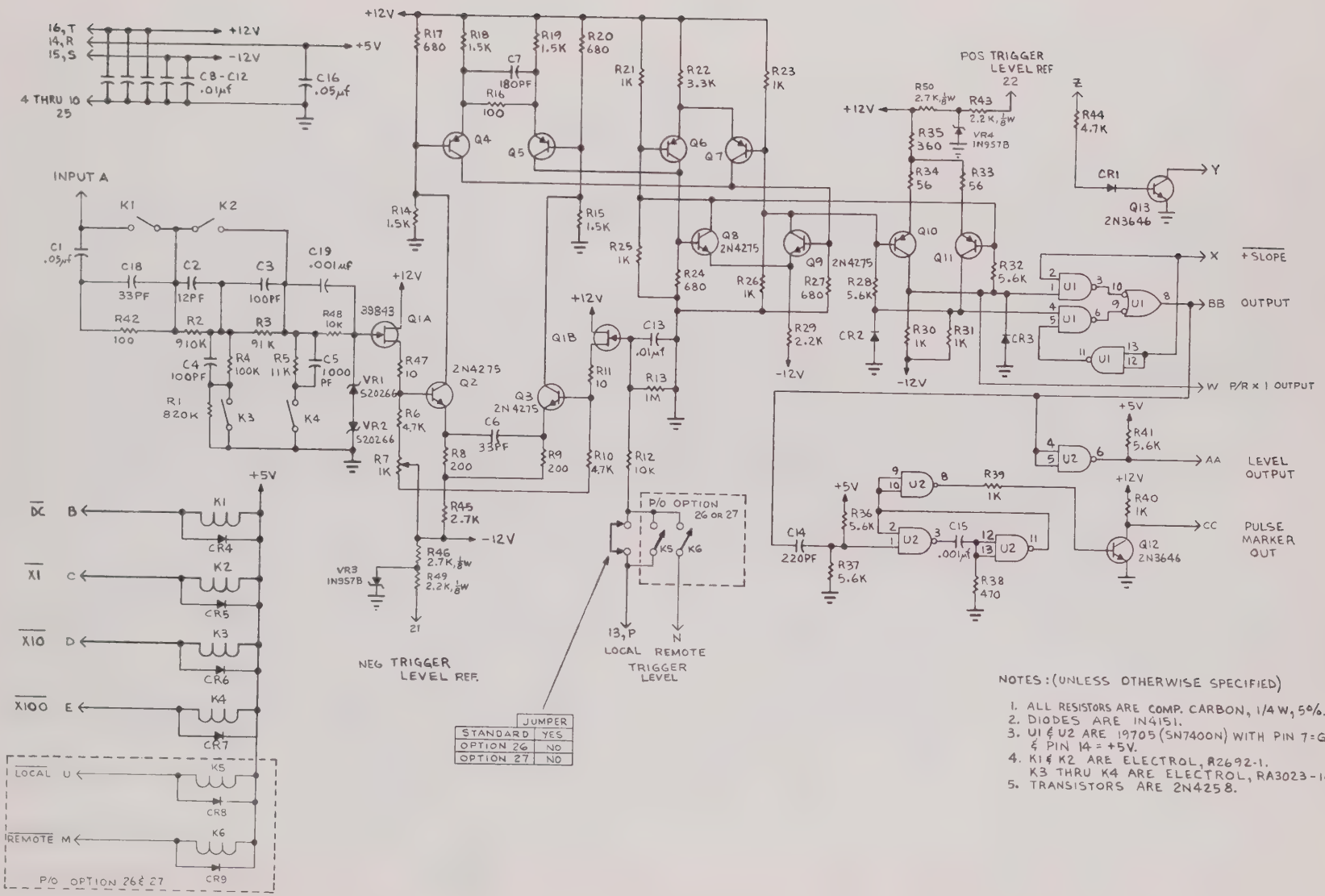
A16, 200 MHz AMPLIFIER P.C. ASSEMBLY #B39323E



A16, 200 MHz AMPLIFIER SCHEMATIC #C39320G



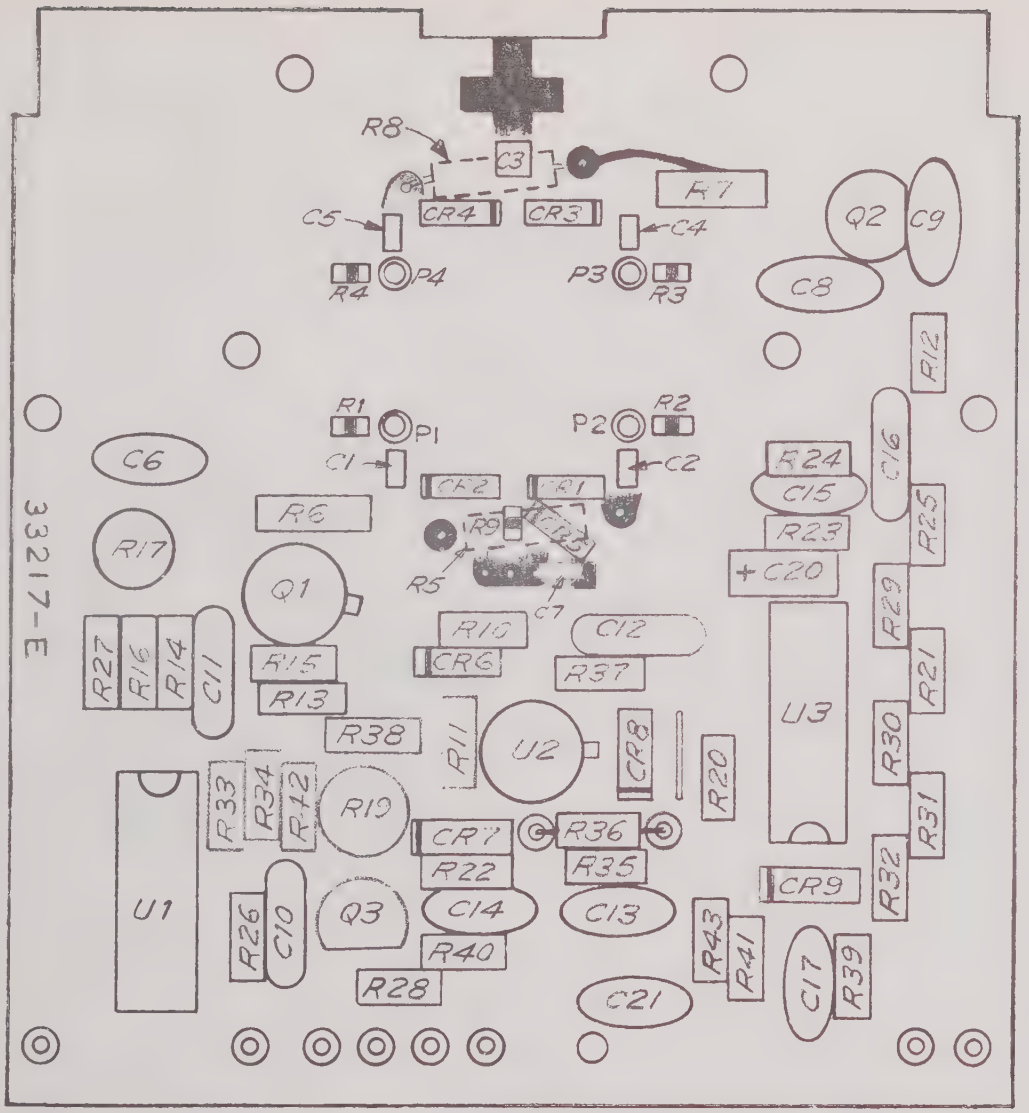
A18, A19, 10 MHz AMPLIFIER P.C. ASSEMBLY #B39331B



NOTES: (UNLESS OTHERWISE SPECIFIED)

1. ALL RESISTORS ARE COMP. CARBON, 1/4 W, 5%.
2. DIODES ARE IN4151.
3. U1 & U2 ARE 19705 (SN7400N) WITH PIN 7=GRD. & PIN 14 = +5V.
4. K1 & K2 ARE ELECTROL, R2692-1. K3 THRU K4 ARE ELECTROL, RA3023-1051.
5. TRANSISTORS ARE 2N4258.

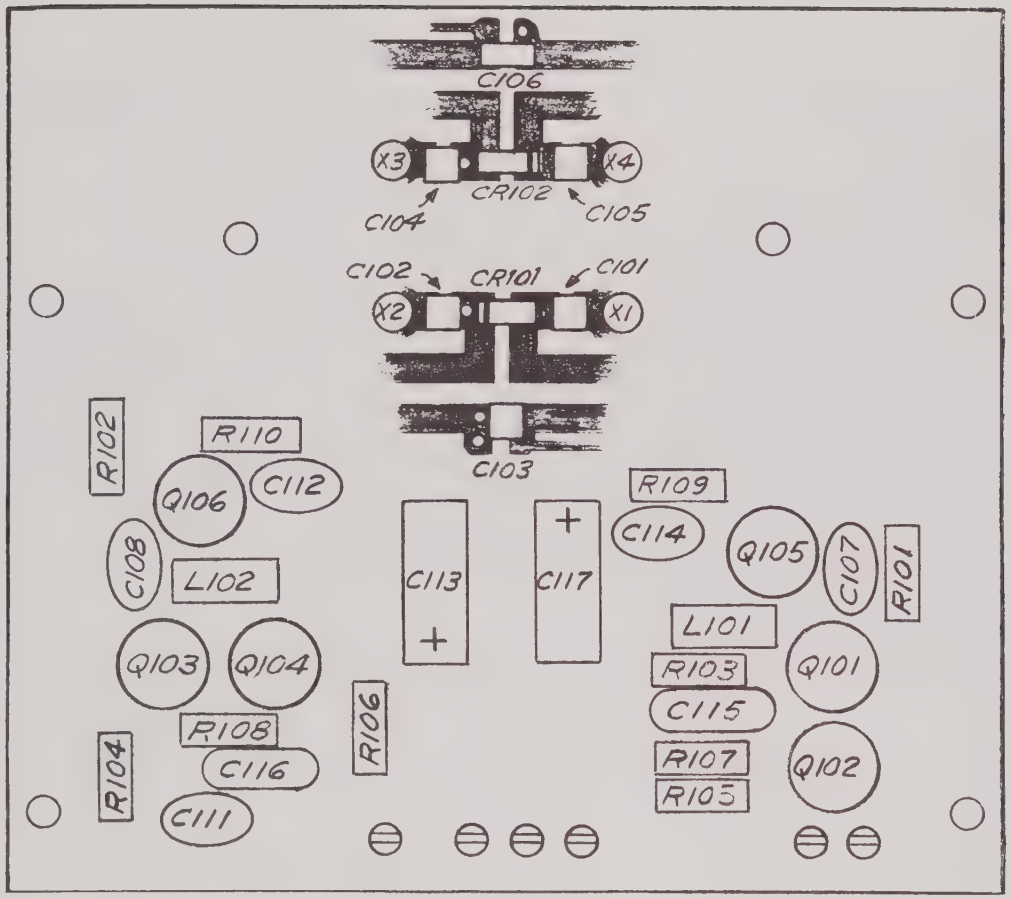
A18, A19, 10 MHz AMPLIFIER SCHEMATIC #C39328D



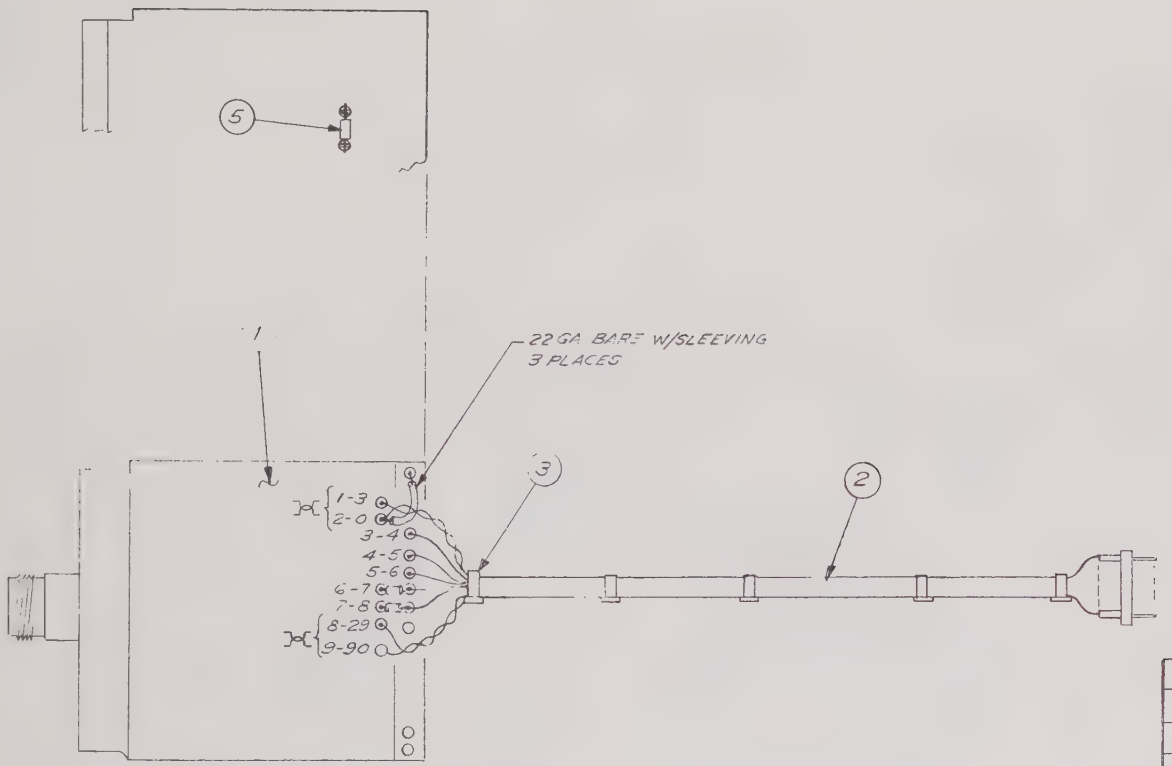
NOTE:

1) RESISTORS $\frac{1}{8}$W, 5% SPECIFIED IN OHMS.
2) CAPACITORS - MORE THAN "ONE" IN pF.
   -LESS " " " µF.
3) INSTALL R1, R2, R3, R4 & R9 BLACK SIDE UP, CENTERED ON TRACE WITH LOW TEMPERATURE SOLDER.
4) CONDUCTIVE CEMENT ON CHIP CAPACITORS. (ECOBAND 56C OR EQUIV.) CURE MIN. 2 HOURS @ 55°C.
5) A RESISTOR IS USED ON SOME EARLY UNITS FROM TP1 TO THE +5V OR -5V LUG. THE VALUE IS SOME 5% INCREMENT BETWEEN 20k & 100k

A20, MIXER P.C. ASSEMBLY #C33218K



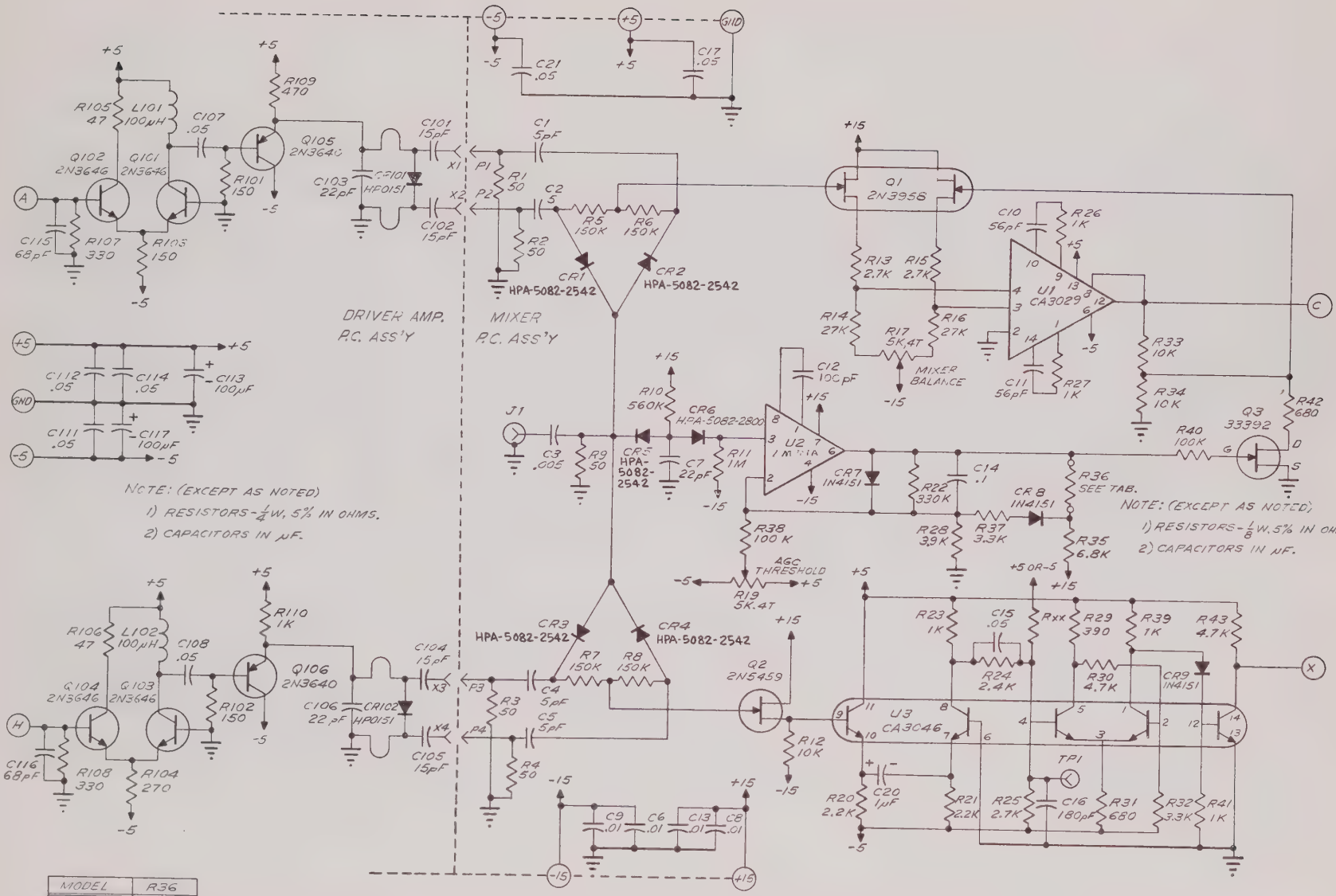
A20, DRIVER AMPLIFIER P.C. ASSEMBLY #C33221G



NOTE:
1) SOLDER WIRES & JUMPERS TO ITEM (1)
2) ADD 4 CABLE TIES.

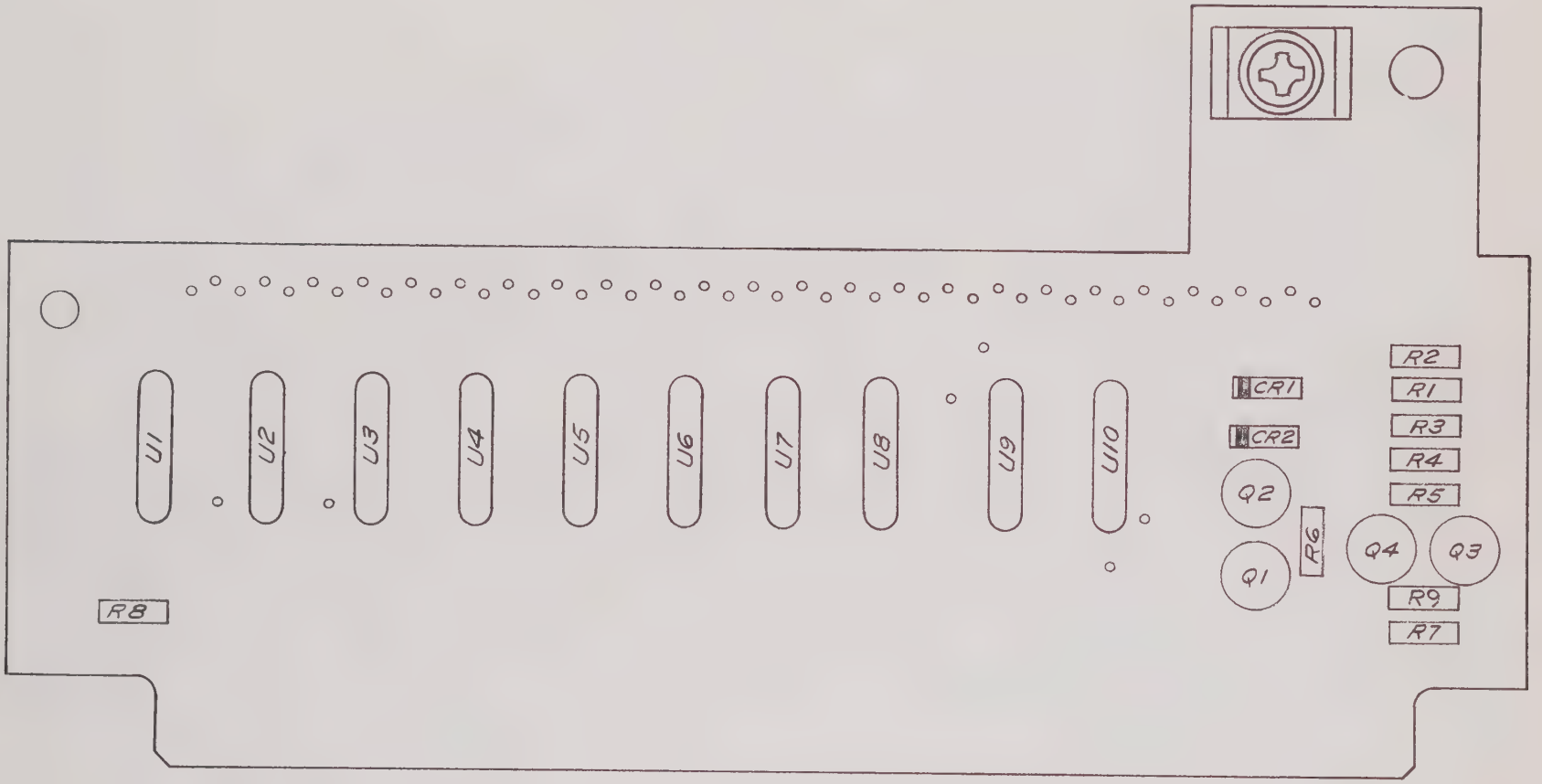
ITEM	Q.Y	PART N:	DESCRIPTION
5	1	P1435	RESISTOR (R36 1.6K 1/2W, 5%)
4			
3	4	H-1104	CABLE TIE
2	1	A39783	MIXER CABLE PLUG ASS'Y P1
1	1	C33351	MIXER ASS'Y

A20, MIXER CABLE ASSEMBLY #B39784C

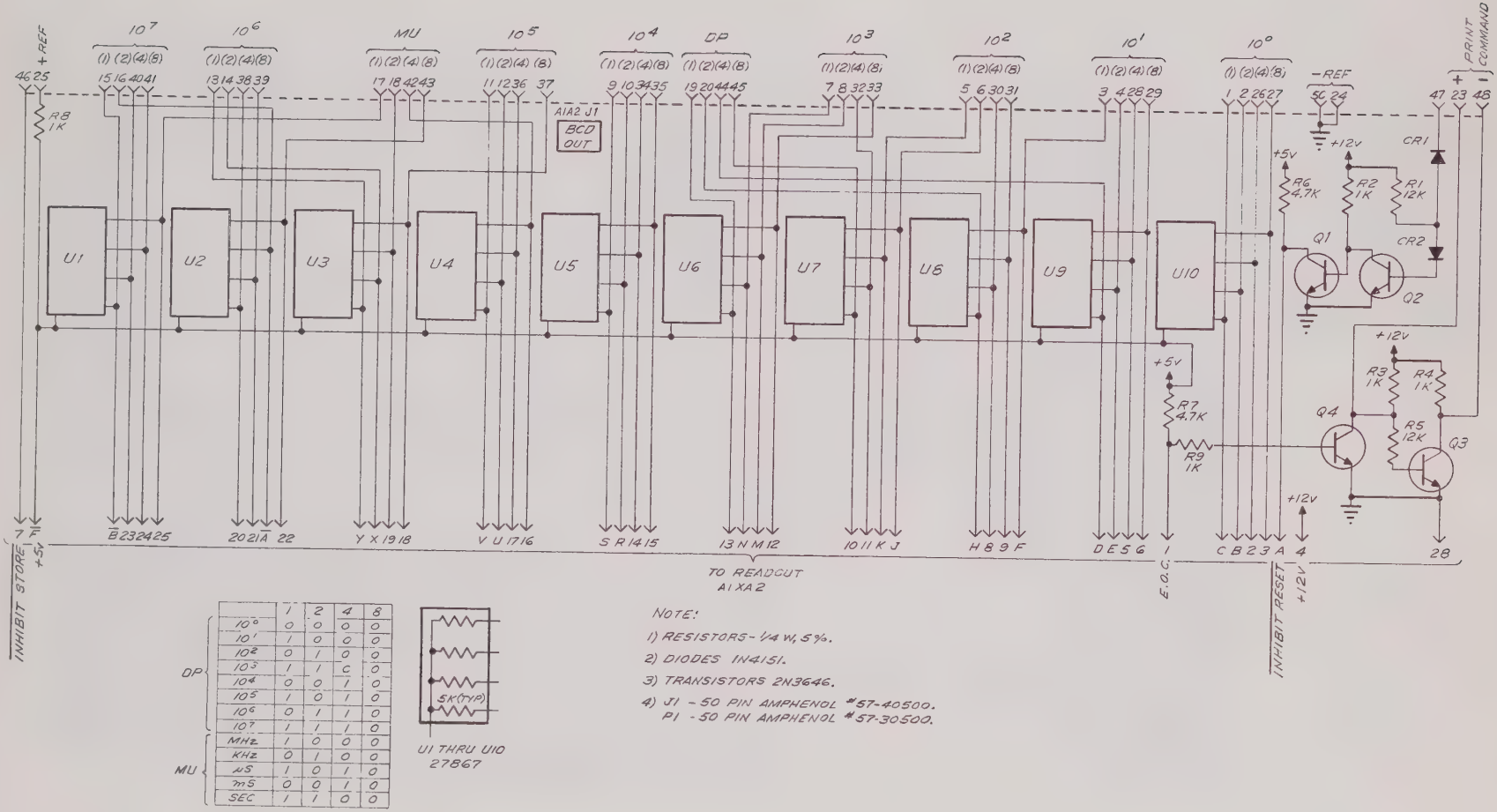


MODEL	R36
153	1.5K
6053	1.5K
6153	1.8K

A20, MIXER & DRIVER AMPLIFIER SCHEMATIC #C27988L



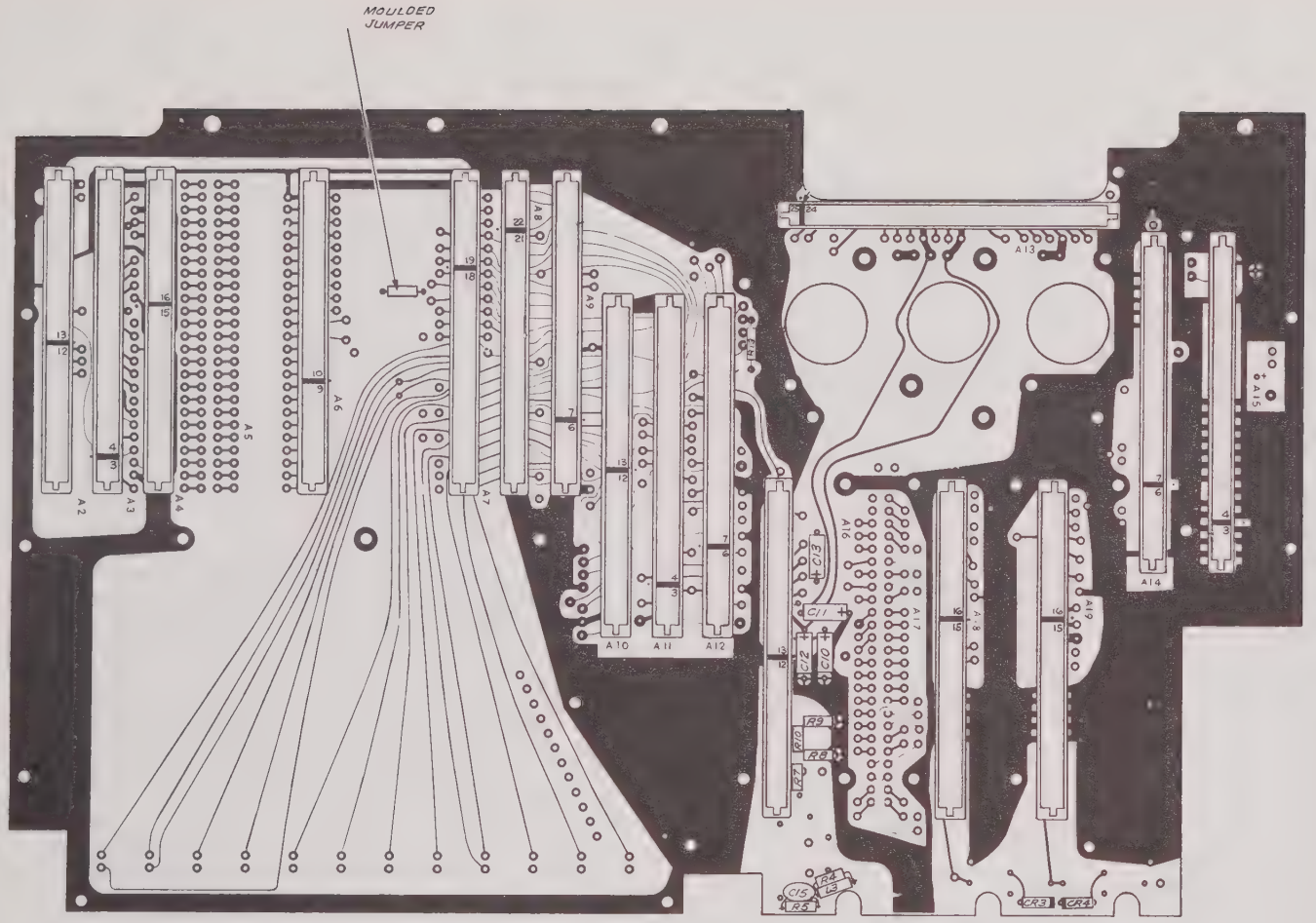
A1A2, BCD OUTPUT P.C. ASSEMBLY #B39379A



NOTE:

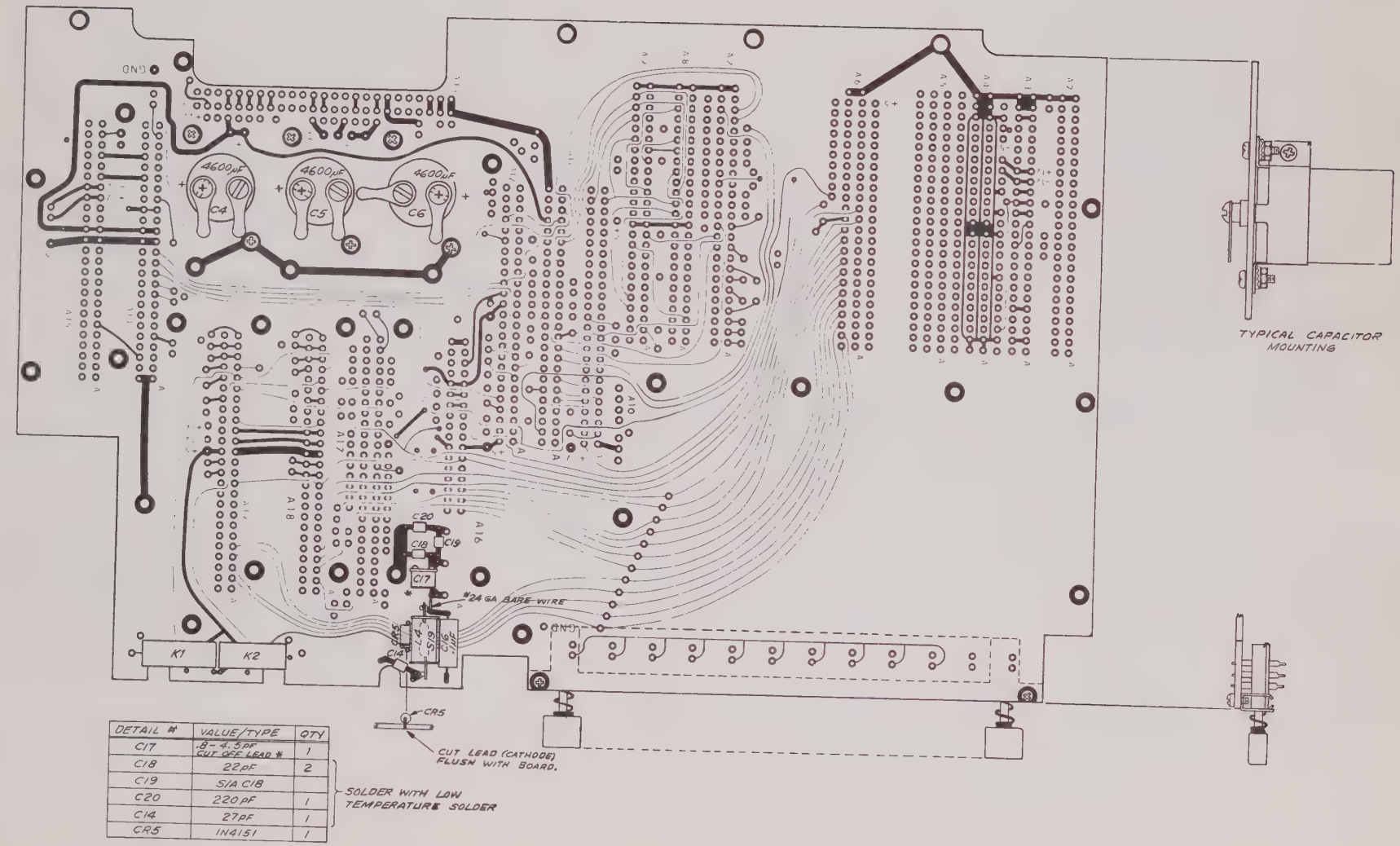
1) RESISTORS - 1/4 W, 5%.
2) DIODES IN4151.
3) TRANSISTORS 2N3646.
4) J1 - 50 PIN AMPHENOL #57-40500.
   P1 - 50 PIN AMPHENOL #57-30500.

A1A2, BCD OUTPUT SCHEMATIC #C39376B



DETAIL #	VALUE/TYPE	QTY
C10, C11, C12, C13	4.7 μF	4
C15	.001 μF	1
CR3, CR4	IN4151	2
L3	.06 μh	1
R4	22 Ω, ¼W	1
R5	100 Ω, ¼W	1
R7	910K, ¼W	1
R8	200K, ¼W	1
R9	20K, ¼W	1
R10	180K, ¼W	1
R13	47 Ω ¼W	1

MOTHER BOARD P.C. ASSEMBLY #C39114E (Sheet 1 of 2)



DETAIL #	VALUE/TYPE	QTY
C17	.8 - 4.5 pF CUT OFF LEAD #	1
C18	22 pF	2
C19	S/A C18	
C20	220 pF	1
C14	27 pF	1
CR5	IN4151	1

MOTHER BOARD P.C. ASSEMBLY #C39114E (Sheet 2 of 2)

CHAPTER 8
OPTIONS

8.1 INTRODUCTION

This chapter contains the option descriptions added to the standard Model 6150-50. Each option is described in a separate package and identified with the option title and number at the bottom of the page.

OPTION 01
DIGITAL OUTPUTS
(BCD, POSITIVE TRUE +5 V)

DESCRIPTION

This assembly provides a means of interconnecting BCD, option 01, information from the Readout, A1, storage to the BCD output connector J12. A 5 kΩ pullup resistor A1A2, U1-U10 is provided for each BCD line. Positive true logic is employed; however, to inhibit the automatic reset, a closure to ground is required. The EOC (end-of-count) or Print Command is either a positive going (pin 23) or a negative going (pin 48) signal output. These print command signals are from a +12 V source through a 1 kΩ resistor to be compatible with certain printers.

SPECIFICATIONS

Output:	Four line BCD (1-2-4-8), all indicators, decimal points, and measurement units. "1" state (true): >+3.5 V "0" state (false): <+0.8 V
Impedance:	TTL output
Reference Levels:	Positive reference = +5 V through 1 kΩ Negative reference = ground
Print Command:	+12 V to 0 V step (negative print command) and 0 V to +12 V (positive print command) with 1 kΩ source, dc coupled.
Hold Off Requirement:	≥0 V to +0.8 V to inhibit instrument; >+1.8 V to enable.
Connector:	Amphenol 50-pin, P.N 57-30500-375, A1A2, J1

BCD OUTPUT PIN ASSIGNMENTS

(See following pages)

DRAWINGS

Option 01, A1A2, BCD Output P.C. Assembly #B39379
Option 01, A1A2, BCD Output P.C. Schematic #C39376
Option 01, A1A2, BCD Output P.C. Assembly Parts List #P/L39379

BCD OUTPUT PIN ASSIGNMENTS

NUMERICAL INDICATION on COUNTER	BCD	PIN
10^0	1	1
	2	2
	4	26
	8	27
10^1	1	3
	2	4
	4	28
	8	29
10^2	1	5
	2	6
	4	30
	8	31
10^3	1	7
	2	8
	4	32
	8	33
10^4	1	9
	2	10
	4	34
	8	35
10^5	1	11
	2	12
	4	36
	8	37
10^6	1	13
	2	14
	4	38
	8	39
10^7	1	15
	2	16
	4	40
	8	41

ANNUNCIATOR	1	17
	2	18
	4	42
	8 (Gnd)	43

ANNUNCIATOR TRANSLATIONS

Measurement:	* = Binary 0
	MHz = Binary 1
	KHz = Binary 2
	sec = Binary 3
	ms = Binary 4
	µs = Binary 5

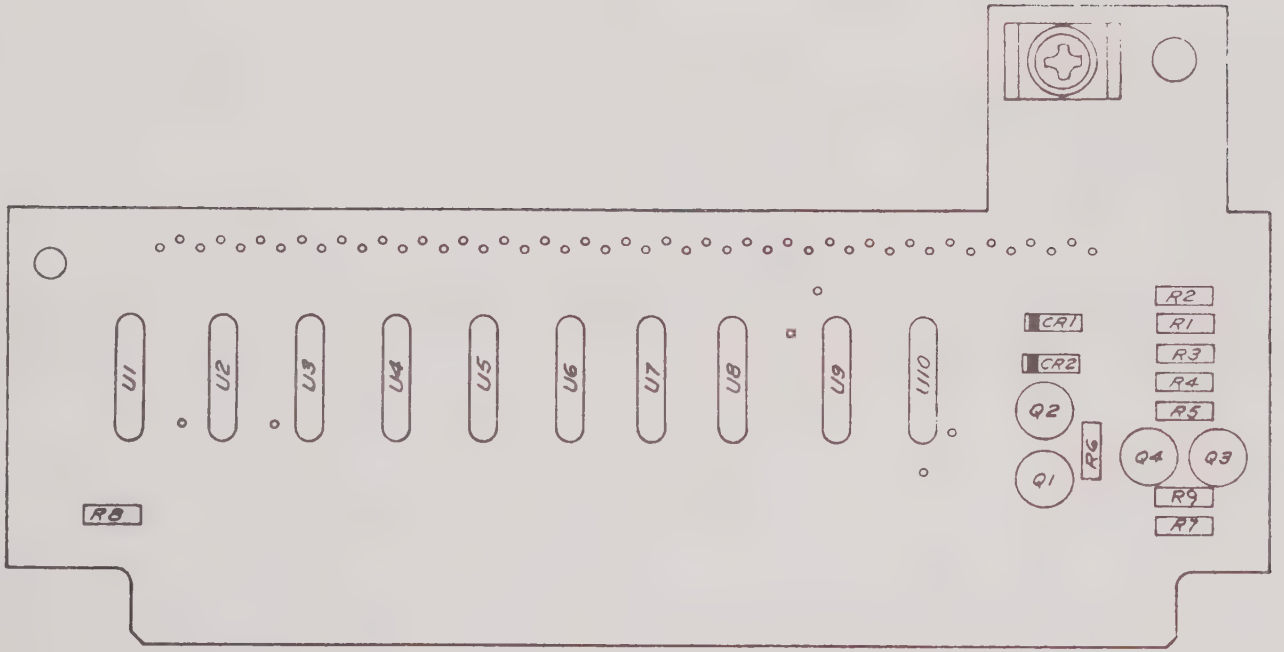
DECIMAL POINT	1	19
	2	20
	4	44
	8	45

DECIMAL TRANSLATION

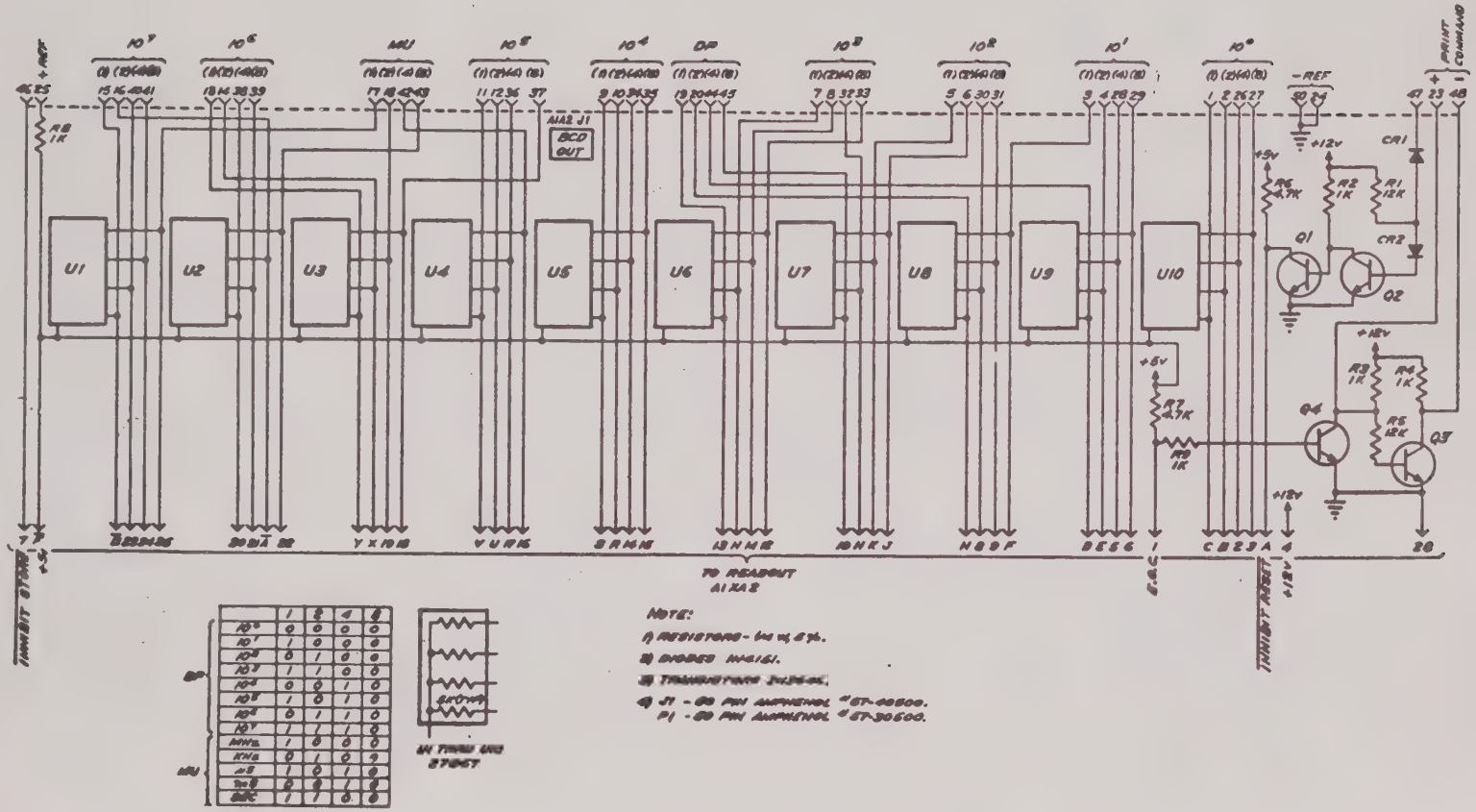
Readout Location	10^0 = Binary 0
	10^1 = Binary 1
	10^2 = Binary 2
	10^3 = Binary 3
	10^4 = Binary 4
	10^5 = Binary 5
	10^6 = Binary 6
	10^7 = Binary 7

RECORDER CONTROL

+ Reference	25
-Reference	24
Instrument Gnd	50
+Print Command	23
Reset Inhibit	47
-Print Command	48
Inhibit Store	46



OPTION 01, A1A2, BCD OUTPUT P.C. ASSEMBLY #B39379



OPTION 01, A1A2, BCD OUTPUT P.C. SCHEMATIC #C39379

OPTION 01, A1A2, BCD OUTPUT P.C. ASSEMBLY PARTS LIST

Ref.	Description	SD Part No.
A1A2	Option 01 BCD Output P.C. Assembly	B39379
A1A2	Option 01 BCD Output Schematic	C39376
	BCD Output Cable Assembly	C39712
CR1	Diode, 1N4151	CR0150
CR2	Diode, 1N4151	CR0150
R1	Resistor, 12 k, 5%, 1/4 W	R0759
R2	Resistor, 1 k, 5%, 1/4 W	R0765
R3	Resistor, 1 k, 5%, 1/4 W	R0765
R4	Resistor, 1 k, 5%, 1/4 W	R0765
R5	Resistor, 12 k, 5%, 1/4 W	R0759
R6	Resistor, 4.7 k, 5%, 1/4 W	R0892
R7	Resistor, 4.7 k, 5%, 1/4 W	R0892
R8	Resistor, 1 k, 5%, 1/4 W	R0765
R9	Resistor, 1 k, 5%, 1/4 W	R0765
U1	Resistor Network, 4 x 5 k, 20%, 1/10 W	27867
U2	Resistor Network, 4 x 5 k, 20%, 1/10 W	27867
U3	Resistor Network, 4 x 5 k, 20%, 1/10 W	27867
U4	Resistor Network, 4 x 5 k, 20%, 1/10 W	27867
U5	Resistor Network, 4 x 5 k, 20%, 1/10 W	27867
U6	Resistor Network, 4 x 5 k, 20%, 1/10 W	27867
U7	Resistor Network, 4 x 5 k, 20%, 1/10 W	27867
U8	Resistor Network, 4 x 5 k, 20%, 1/10 W	27867
U9	Resistor Network, 4 x 5 k, 20%, 1/10 W	27867
U10	Resistor Network, 4 x 5 k, 20%, 1/10 W	27867
	Cable Clamp	37021790
	Connector	J0170

OPTION 02
DIGITAL OUTPUTS
(BCD, GROUND TRUE, +5 V)

DESCRIPTION

This assembly provides a means of interconnecting BCD, option 02, information from the Readout, A1, storage to the BCD output connector J12. A 12 kΩ pullup resistor A1A2, U9-U16 is provided for each BCD line. Ground true logic is employed with a closure to ground required to inhibit the automatic reset. The EOC (end-of-count) or Print Command is either a positive going (pin 23) or a negative going (pin 48) signal output. These print command signals are from a +12 V source through a 1 kΩ resistor to be compatible with certain printers.

SPECIFICATIONS

Output:	Four line BCD (1-2-4-8), all indicators, decimal points, and measurement units. "1" state (true): <+0.8 V "0" state (false): >+3.5 V
Impedance:	TTL output
Reference Levels:	High reference = +5 V through 1 kΩ Lo reference = ground
Print Command:	+12 V to 0 V step (negative print command) and 0 V to +12 V (positive print command) with 1 kΩ source, dc coupled.
Hold Off Requirement:	≥0 V to +0.8 V to inhibit instrument; >+1.8 V to enable.
Connector:	Amphenol 50-pin, P/N 57-30500-375, A1A2, J1

BCD OUTPUT PIN ASSIGNMENTS

(See following pages)

DRAWINGS

Option 02, A1A2, BCD Output P.C. Assembly #C45059
Option 02, A1A2, BCD Output Schematic #D45022
Option 02, A1A2, BCD Output P.C. Assembly Parts List #P/L45059

BCD OUTPUT PIN ASSIGNMENTS

NUMERICAL INDICATION on COUNTER	BCD	PIN
10^0	1	1
	2	2
	4	26
	8	27
10^1	1	3
	2	4
	4	28
	8	29
10^2	1	5
	2	6
	4	30
	8	31
10^3	1	7
	2	8
	4	32
	8	33
10^4	1	9
	2	10
	4	34
	8	35
10^5	1	11
	2	12
	4	36
	8	37
10^6	1	13
	2	14
	4	38
	8	39
10^7	1	15
	2	16
	4	40
	8	41

ANNUNCIATOR	1	17
	2	18
	4	42
	8	43

ANNUNCIATOR TRANSLATIONS

Measurement:	*	= Binary 0
	MHz	= Binary 1
	KHz	= Binary 2
	sec	= Binary 3
	ms	= Binary 4
	µs	= Binary 5

DECIMAL POINT	1	19
	2	20
	4	44
	8	45

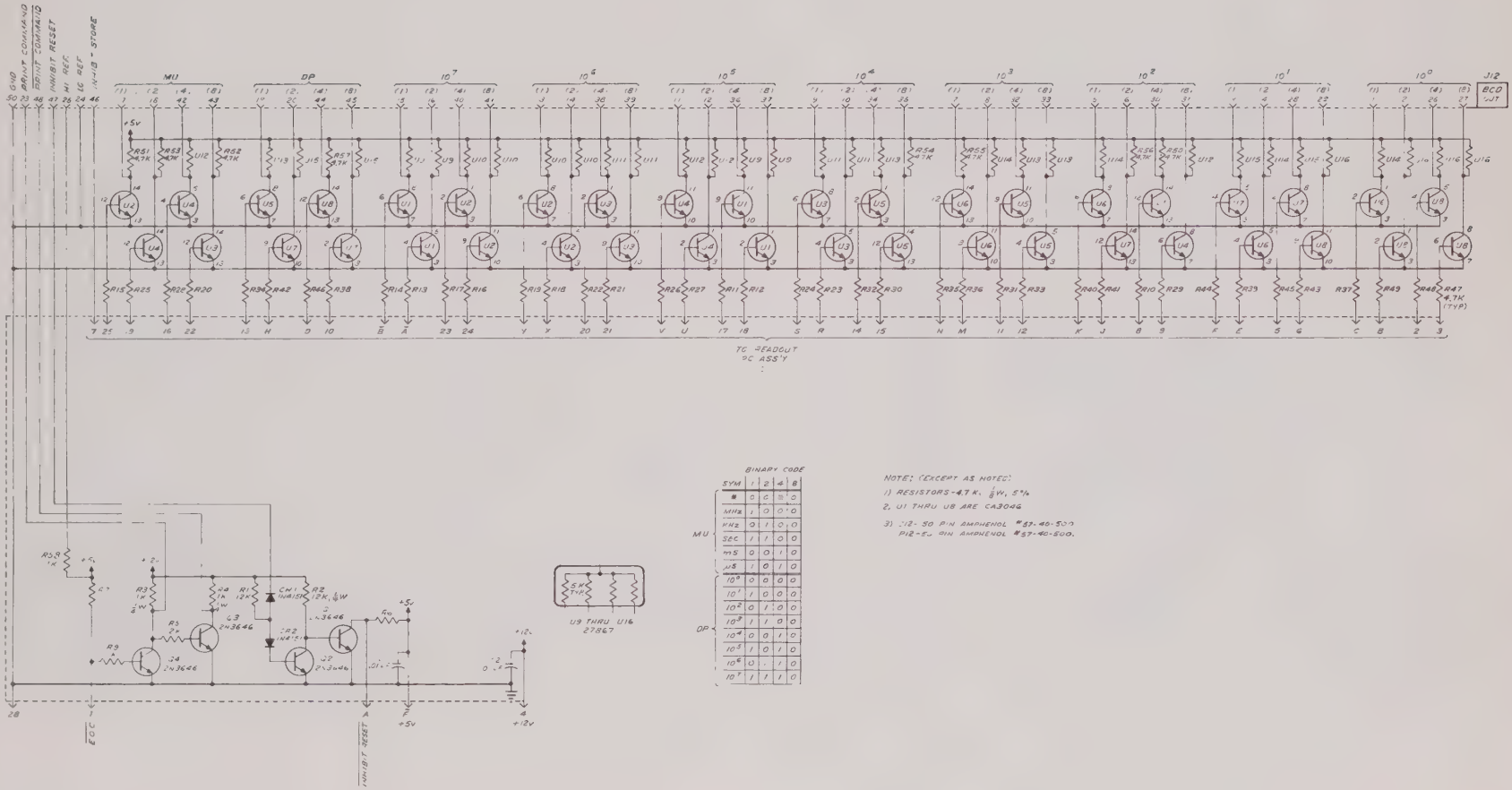
DECIMAL TRANSLATION

Readout Location	10^0	= Binary 0
	10^1	= Binary 1
	10^2	= Binary 2
	10^3	= Binary 3
	10^4	= Binary 4
	10^5	= Binary 5
	10^6	= Binary 6
	10^7	= Binary 7

RECORDER CONTROL

HI Reference	25
LO Reference	24
Instrument Gnd	50
Print Command	23
Inhibit Reset	47
Print Command	48
Inhibit Store	46

OPTION 02, A1A2, BCD OUTPUT P.C. ASSEMBLY #C45059



OPTION 02, A1A2, BCD OUTPUT SCHEMATIC #D45022

OPTION 02 FINAL ASSEMBLY PARTS LIST

Ref.	Description	SD Part No.
	Option 02 Final Assembly	C45352
	ADD	
	+5V Negative True BCD Output Assembly consists of:	C45351
4	+5V Negative True BCD Output P.C. Assembly	C45059
5	Negative True BCD Output Cable Assembly	C45341
P12	Connector, w/hood, 50 pin	J0171
	* * * * * * * * * * * * * * * * * * * *	
	+5V Negative True BCD Output P.C. Assembly	C45049
	+5V Negative True BCD Output P.C. Schematic	D45022
C1	Capacitor, .01 F, 100 V	C0556
C2	Capacitor, .01 F, 100 V	C0556
CR1	Diode, 1N4151	CR0150
CR2	Diode, 1N4151	CR0150
Q1	Transistor, 2N3646	Q0218
Q2	Transistor, 2N3646	Q0218
Q3	Transistor, 2N3646	Q0218
Q4	Transistor, 2N3646	Q0218
R1	Resistor, 12 k, 5%, 1/8 W	R2464
R2	Resistor, 12 k, 5%, 1/4 W	R0759
R3	Resistor, 1 k, 5%, 1/4 W	R0765
R4	Resistor, 1 k, 5%, 1/4 W	R0765
R5	Resistor, 12 k, 5%, 1/8 W	R2464
R6	Resistor, 4.7 k, 5%, 1/8 W	R1733
R7	Resistor, 4.7 k, 5%, 1/8 W	R1733
R8	Not Used	
R9	Resistor, 1 k, 5%, 1/8 W	R1453
R10-R57	Resistor, 4.7 k, 5%, 1/8 W	R1733
R58	Resistor, 1 k, 5%, 1/8 W	R1453
U1	Integrated Circuit, CA3046	25725
U2	Integrated Circuit, CA3046	25725
U3	Integrated Circuit, CA3046	25725
U4	Integrated Circuit, CA3046	25725
U5	Integrated Circuit, CA3046	25725
U6	Integrated Circuit, CA3046	25725
U7	Integrated Circuit, CA3046	25725

OPTION 02 FINAL ASSEMBLY PARTS LIST (Cont'd)

Ref.	Description	SD Part No.
U8	Integrated Circuit, CA3046	25725
U9	Resistor Network, 4 x 5 k, 1/10 W	27867
U10	Resistor Network, 4 x 5 k, 1/10 W	27867
U11	Resistor Network, 4 x 5 k, 1/10 W	27867
U12	Resistor Network, 4 x 5 k, 1/10 W	27867
U13	Resistor Network, 4 x 5 k, 1/10 W	27867
U14	Resistor Network, 4 x 5 k, 1/10 W	27867
U15	Resistor Network, 4 x 5 k, 1/10 W	27867
U16	Resistor Network, 4 x 5 k, 1/10 W	27867
	* * * * * * * * * * * * * * * * * * *	
	Negative True BCD Cable Assembly	C45341
J12	Connector, 50 pin	J0170

OPTION 03
DIGITAL OUTPUTS
(BCD, POSITIVE TRUE +12 V)

DESCRIPTION

This assembly provides a means of interconnecting BCD, option 03, information from the Readout, A1, storage to the BCD output connector J12. A 12 kΩ pullup resistor A1A2, U9-U24 is provided for each BCD line. Positive true logic is employed; however, to inhibit the automatic reset, a closure to ground is required. The EOC (end-of-count) or Print Command is either a positive going (pin 23) or a negative going (pin 48) signal output. These print command signals are from a +12 V source through a 1 kΩ resistor to be compatible with certain printers.

SPECIFICATIONS

Output:	Four line BCD (1-2-4-8), all indicators, decimal points, and measurement units. "1" state (true): >10 V "0" state (false): <1 V
Impedance:	12 kΩ source
Reference Levels:	Hi reference = +9 V through 3.3 kΩ Lo reference = +3 V
Print Command:	+12 V to 0 V step (negative print command) and 0 V to +12 V (positive print command) with 1 kΩ source, dc coupled.
Hold Off Requirement:	≥0 V to +0.8 V to inhibit instrument; >+1.8 V to enable.
Connector:	Amphenol 50-pin, P/N 57-30500-375, A1A2, J1

BCD OUTPUT PIN ASSIGNMENTS

(See following pages)

DRAWINGS

Option 03, A1A2, BCD Output P.C. Assembly #B45107
Option 03, A1A2, BCD Output P.C. Schematic #D45104
Option 03, A1A2, BCD Output P.C. Assembly Parts List #P/L45107

BCD OUTPUT PIN ASSIGNMENTS

NUMERICAL INDICATION on COUNTER	BCD	PIN
10^0	1	1
	2	2
	4	26
	8	27
10^1	1	3
	2	4
	4	28
	8	29
10^2	1	5
	2	6
	4	30
	8	31
10^3	1	7
	2	8
	4	32
	8	33
10^4	1	9
	2	10
	4	34
	8	35
10^5	1	11
	2	12
	4	36
	8	37
10^6	1	13
	2	14
	4	38
	8	39
10^7	1	15
	2	16
	4	40
	8	41

ANNUNCIATOR	1	17
	2	18
	4	42
	8	43

ANNUNCIATOR TRANSLATIONS

Measurement:	*	= Binary 0
	MHz	= Binary 1
	KHz	= Binary 2
	sec	= Binary 3
	ms	= Binary 4
	µs	= Binary 5

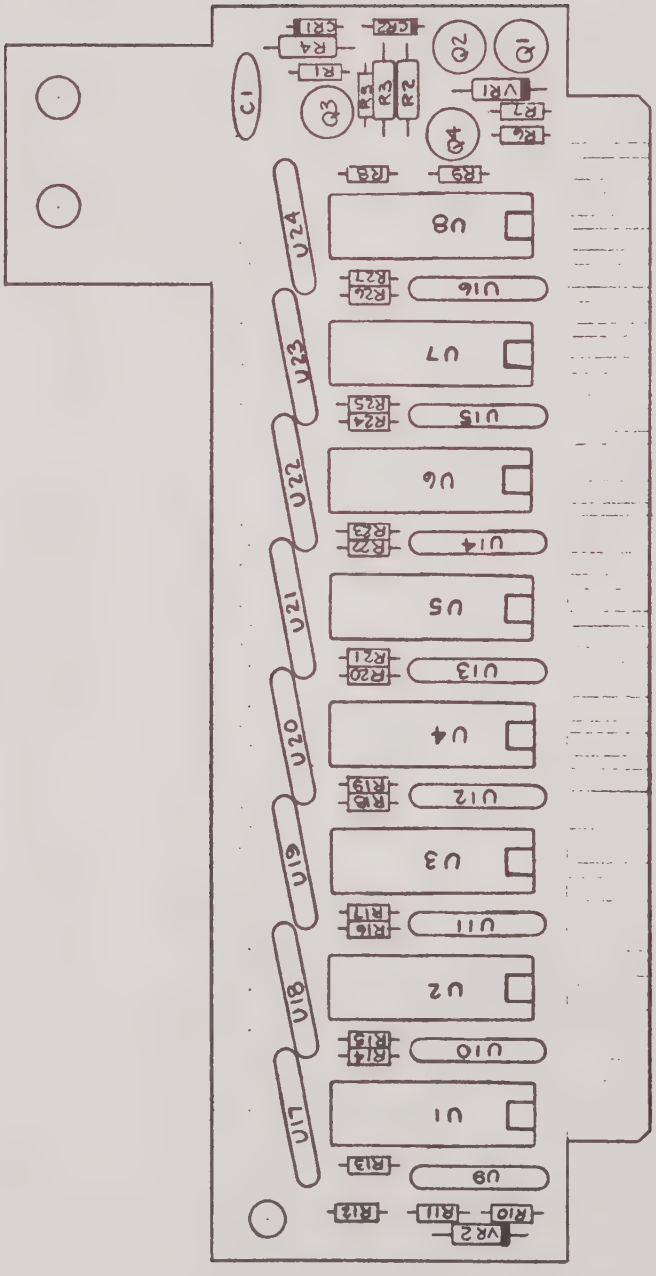
DECIMAL POINT	1	19
	2	20
	4	44
	8	45

DECIMAL TRANSLATION

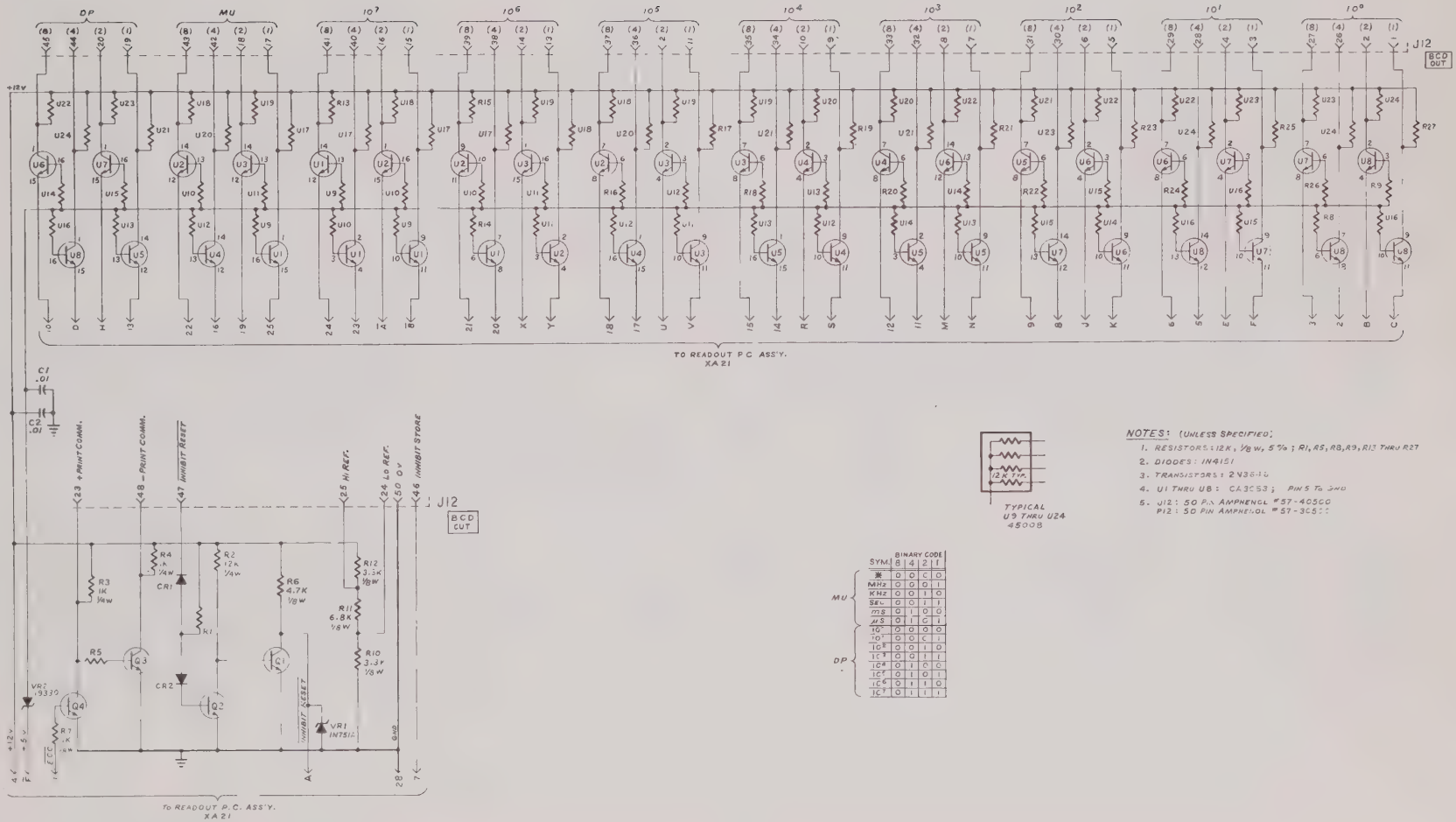
Readout Location	10^0	= Binary 0
	10^1	= Binary 1
	10^2	= Binary 2
	10^3	= Binary 3
	10^4	= Binary 4
	10^5	= Binary 5
	10^6	= Binary 6
	10^7	= Binary 7

RECORDER CONTROL

Hi Reference	25
Lo Reference	24
Instrument Gnd	50
+Print Command	23
$\overline{\text{Inhibit Reset}}$	47
-Print Command	48
Inhibit Store	46



OPTION 03, A1A2, BCD OUTPUT P.C. ASSEMBLY #B45107



NOTES: (UNLESS SPECIFIED)

1. RESISTORS: 12K, 1/8W, 5%; R1, A5, R8, A9, R13 THRU R27
2. DIODES: IN4151
3. TRANSISTORS: 2N3646
4. U1 THRU U8: CA3053; PIN 5 TO GND
5. J12: 50 PIN AMPHENOL #57-40500
   P12: 50 PIN AMPHENOL #57-30500

	SYM.	BINARY CODE 8	4	2	1
	※	0	0	0	0
MU	MHz	0	0	0	1
MU	KHz	0	0	1	0
MU	SEC	0	0	1	1
MU	10^8	0	1	0	0
MU	10^9	0	1	0	1
DP	10^0	0	0	0	0
DP	10^1	0	0	0	1
DP	10^2	0	0	1	0
DP	10^3	0	0	1	1
DP	10^4	0	1	0	0
DP	10^5	0	1	0	1
DP	10^6	0	1	1	0
DP	10^7	0	1	1	1

OPTION 03, A1A2, BCD OUTPUT SCHEMATIC #D45104

OPTION 03 FINAL ASSEMBLY PARTS LIST

Ref.	Description	SD Part No.
	Option 03 Final Assembly	C45378
	ADD	
4	+12V Positive True BCD Output Assembly consists of:	C45377
4	+12V Positive True BCD Output P.C. Assembly	B45107
5	+12V Positive True BCD Output Cable Assembly	C45122
P12	Connector w/hood, 50 pin	J0171
	* * * * * * * * * * * * * * * * * * * *	
	+12V Positive True BCD Output P.C. Assembly	B45107
	+12V Positive True BCD Output P.C. Schematic	D45104
C1	Capacitor, .01 µF, 100 V	C0556
CR1	Diode, 1N4151	CR0150
CR2	Diode, 1N4151	CR0150
Q1	Transistor, 2N3646	Q0218
Q2	Transistor, 2N3646	Q0218
Q3	Transistor, 2N3646	Q0218
Q4	Transistor, 2N3646	Q0218
R1	Resistor, 12 k, 5%, 1/8 W	R2464
R2	Resistor, 12 k, 5%, 1/4 W	R0759
R3	Resistor, 1 k, 5%, 1/4 W	R0765
R4	Resistor, 1 k, 5%, 1/4 W	R0765
R5	Resistor, 12 k, 5%, 1/8 W	R2464
R6	Resistor, 4.7 k, 5%, 1/8 W	R1733
R7	Resistor, 1 k, 5%, 1/8 W	R1453
R8	Resistor, 12 k, 5%, 1/8 W	R2464
R9	Resistor, 12 k, 5%, 1/8 W	R2464
R10	Resistor, 3.3 k, 5%, 1/8 W	R1456
R11	Resistor, 6.8 k, 5%, 1/8 W	R1459
R12	Resistor, 3.3 k, 5%, 1/8 W	R1456
R13	Resistor, 12 k, 5%, 1/8 W	R2464
R14	Resistor, 12 k, 5%, 1/8 W	R2464
R15	Resistor, 12 k, 5%, 1/8 W	R2464
R16	Resistor, 12 k, 5%, 1/8 W	R2464
R17	Resistor, 12 k, 5%, 1/8 W	R2464
R18	Resistor, 12 k, 5%, 1/8 W	R2464
R19	Resistor, 12 k, 5%, 1/8 W	R2464
R20	Resistor, 12 k, 5%, 1/8 W	R2464

OPTION 03 FINAL ASSEMBLY PARTS LIST (Cont'd)

Ref.	Description	SD Part No.
R21	Resistor, 12 k, 5%, 1/8 W	R2464
R22	Resistor, 12 k, 5%, 1/8 W	R2464
R23	Resistor, 12 k, 5%, 1/8 W	R2464
R24	Resistor, 12 k, 5%, 1/8 W	R2464
R25	Resistor, 12 k, 5%, 1/8 W	R2464
R26	Resistor, 12 k, 5%, 1/8 W	R2464
R27	Resistor, 12 k, 5%, 1/8 W	R2464
U1	Integrated Circuit, CA3083	25790
U2	Integrated Circuit, CA3083	25790
U3	Integrated Circuit, CA3083	25790
U4	Integrated Circuit, CA3083	25790
U5	Integrated Circuit, CA3083	25790
U6	Integrated Circuit, CA3083	25790
U7	Integrated Circuit, CA3083	25790
U8	Integrated Circuit, CA3083	25790
U9	Resistor Network, 12 k, 1/10 W	45008
U10	Resistor Network, 12 k, 1/10 W	45008
U11	Resistor Network, 12 k, 1/10 W	45008
U12	Resistor Network, 12 k, 1/10 W	45008
U13	Resistor Network, 12 k, 1/10 W	45008
U14	Resistor Network, 12 k, 1/10 W	45008
U15	Resistor Network, 12 k, 1/10 W	45008
U16	Resistor Network, 12 k, 1/10 W	45008
U17	Resistor Network, 12 k, 1/10 W	45008
U18	Resistor Network, 12 k, 1/10 W	45008
U19	Resistor Netwrok, 12 k, 1/10 W	45008
U20	Resistor Network, 12 k, 1/10 W	45008
U21	Resistor Network, 12 k, 1/10 W	45008
U22	Resistor Network, 12 k, 1/10 W	45008
U23	Resistor Network, 12 k, 1/10 W	45008
U24	Resistor Network, 12 k, 1/10 W	45008
VR1	Diode, Breadkown 1N751A	CR0095
VR2	Diode, Breakdown 19330	19330
	* * * * * * * * * * * * * * * * * * * *	
	+12V Positive True BCD Output Cable Assembly	C45122
J12	Connector, 50 pin	J0170

OPTION 04
DIGITAL OUTPUTS
(BCD, GROUND TRUE +12 V)

DESCRIPTION

This assembly provides a means of interconnecting BCD, option 04, information from the Readout, A1, storage to the BCD output connector J12. A 12 kΩ pullup resistor A1A2, U9-U16 is provided for each BCD line. Ground true logic is employed with a closure to ground required to inhibit the automatic reset. The EOC (end-of-count) or Print Command is either a positive going (pin 23) or a negative going (pin 48) signal output. These print command signals are from a +12 V source through a 1 kΩ resistor to be compatible with certain printers.

SPECIFICATIONS

Output:	Four line BCD (1-2-4-8), all indicators, decimal points, and measurement units. "1" state (true): +.5 V, 5 mA sink "0" state (false): +12 V
Impedance:	"0" = 12 kΩ **source** and "1" = 5 mA sink
Reference Levels:	Hi reference = +9 V through 3.3 kΩ Lo reference = 3 V
Print Command:	+12 V to 0 V step (negative print command) and 0 V to +12 V (positive print command) with 1 kΩ source, dc coupled.
Hold Off Requirement:	≥0 V to +0.8 V to inhibit instrument; >+1.8 V to enable.
Connector:	Amphenol 50-pin, P/N 57-30500-375, A1A2, J1

BCD OUTPUT PIN ASSIGNMENTS

(See following pages)

DRAWINGS

Option 04, A1A2, BCD Output P.C. Assembly #C45025
Option 04, A1A2, BCD Output P.C. Schematic #D45021
Option 04, A1A2, BCD Output P.C. Assembly Parts List #P/L45025

BCD OUTPUT PIN ASSIGNMENTS

NUMERICAL INDICATION on COUNTER	BCD	PIN
10^0	1	1
	2	2
	4	26
	8	27
10^1	1	3
	2	4
	4	28
	8	29
10^2	1	5
	2	6
	4	30
	8	31
10^3	1	7
	2	8
	4	32
	8	33
10^4	1	9
	2	10
	4	34
	8	35
10^5	1	11
	2	12
	4	36
	8	37
10^6	1	13
	2	14
	4	38
	8	39
10^7	1	15
	2	16
	4	40
	8	41

ANNUNCIATOR	1	17
	2	18
	4	42
	8	43

ANNUNCIATOR TRANSLATIONS

Measurement:	*	= Binary 0
	MHz	= Binary 1
	KHz	= Binary 2
	sec	= Binary 3
	ms	= Binary 4
	µs	= Binary 5

DECIMAL POINT	1	19
	2	20
	4	44
	8	45

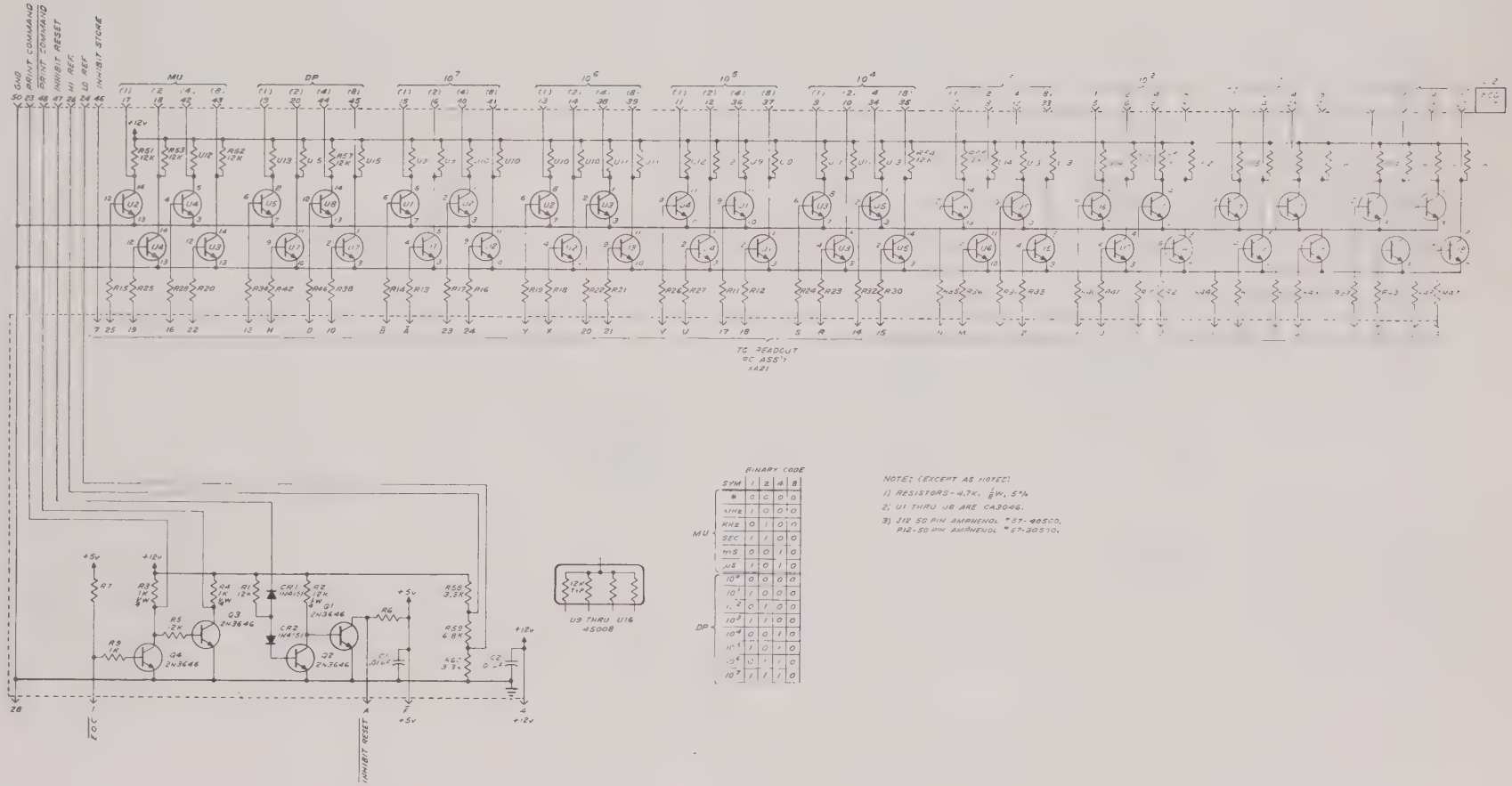
DECIMAL TRANSLATION

Readout Location	10^0	= Binary 0
	10^1	= Binary 1
	10^2	= Binary 2
	10^3	= Binary 3
	10^4	= Binary 4
	10^5	= Binary 5
	10^6	= Binary 6
	10^7	= Binary 7

RECORDER CONTROL

HI Reference	25
LO Reference	24
Instrument Gnd	50
Print Command	23
Inhibit Reset	47
Print Command	48
Inhibit Store	46

OPTION 04, A1A2, BCD OUTPUT P.C. ASSEMBLY #C45025



OPTION 04, A1A2, BCD OUTPUT SCHEMATIC #D45021

OPTION 04 FINAL ASSEMBLY PARTS LIST

Ref.	Description	SD Part No.
	Option 04 Final Assembly	C45359
	ADD	
	+12V Negative True BCD Output Assembly consists of:	C45358
4	+12V Negative True BCD Output P.C. Assembly	C45025
5	Negative True BCD Output Cable Assembly	C45341
P12	Connector, w/hood 50 pin	J0171
	* * * * * * * * * * * * * * * * * * * *	
	+12V Negative True BCD Output P.C. Assembly	C45025
	+12V Negative True BCD Output P.C. Schematic	D45021
C1	Capacitor, .01 µF, 100 V	C0556
C2	Capacitor, .01 µF, 100 V	C0556
CR1	Diode, 1N4151	CR0150
CR2	Diode, 1N4151	CR0150
Q1	Transistor, 2N3646	Q0218
Q2	Transistor, 2N3646	Q0218
Q3	Transistor, 2N3646	Q0218
Q4	Transistor, 2N3646	Q0218
R1	Resistor, 12 k, 5%, 1/8 W	R2464
R2	Resistor, 12 k, 5%, 1/4 W	R0759
R3	Resistor, 1 k, 5%, 1/4 W	R0765
R4	Resistor, 1 k, 5%, 1/4 W	R0765
R5	Resistor, 12 k, 5%, 1/8 W	R2464
R6	Resistor, 4.7 k, 5%, 1/8 W	R1733
R7	Resistor, 4.7 k, 5%, 1/8 W	R1733
R8	Not Used	
R9	Resistor, 1 k, 5%, 1/8 W	R1453
R10-R49	Resistor, 4.7 k, 5%, 1/8 W	R1733
R50	Resistor, 12 k, 5%, 1/8 W	R2464
R51	Resistor, 12 k, 5%, 1/8 W	R2464
R52	Resistor, 12 k, 5%, 1/8 W	R2464
R53	Resistor, 12 k, 5%, 1/8 W	R2464
R54	Resistor, 12 k, 5%, 1/8 W	R2464
R55	Resistor, 12 k, 5%, 1/8 W	R2464
R56	Resistor, 12 k, 5%, 1/8 W	R2464
R57	Resistor, 12 k, 5%, 1/8 W	R2464

OPTION 04 FINAL ASSEMBLY PARTS LIST

Ref.	Description	SD Part No.
R58	Resistor, 3.3 k, 5%, 1/8 W	R1456
R59	Resistor, 6.8 k, 5%, 1/8 W	R1459
R60	Resistor, 3.3 k, 5%, 1/8 W	R1456
U1	Integrated Circuit, CA3046	25725
U2	Integrated Circuit, CA3046	25725
U3	Integrated Circuit, CA3046	25725
U4	Integrated Circuit, CA3046	25725
U5	Integrated Circuit, CA3046	25725
U6	Integrated Circuit, CA3046	25725
U7	Integrated Circuit, CA3046	25725
U8	Integrated Circuit, CA3046	25725
U9	Resistor Network, 4 x 12 k, 1/10 W	45008
U10	Resistor Network, 4 x 12 k, 1/10 W	45008
U11	Resistor Network, 4 x 12 k, 1/10 W	45008
U12	Resistor Network, 4 x 12 k, 1/10 W	45008
U13	Resistor Network, 4 x 12 k, 1/10 W	45008
U14	Resistor Network, 4 x 12 k, 1/10 W	45008
U15	Resistor Network, 4 x 12 k, 1/10 W	45008
U16	Resistor Network, 4 x 12 k, 1/10 W	45008
	* * * * * * * * * * * * * * * * * * *	
	Negative True BCD Cable Assembly	C45341
J12	Connector, 50 pin	J0170

OPTION 10
OSCILLATOR

DESCRIPTION

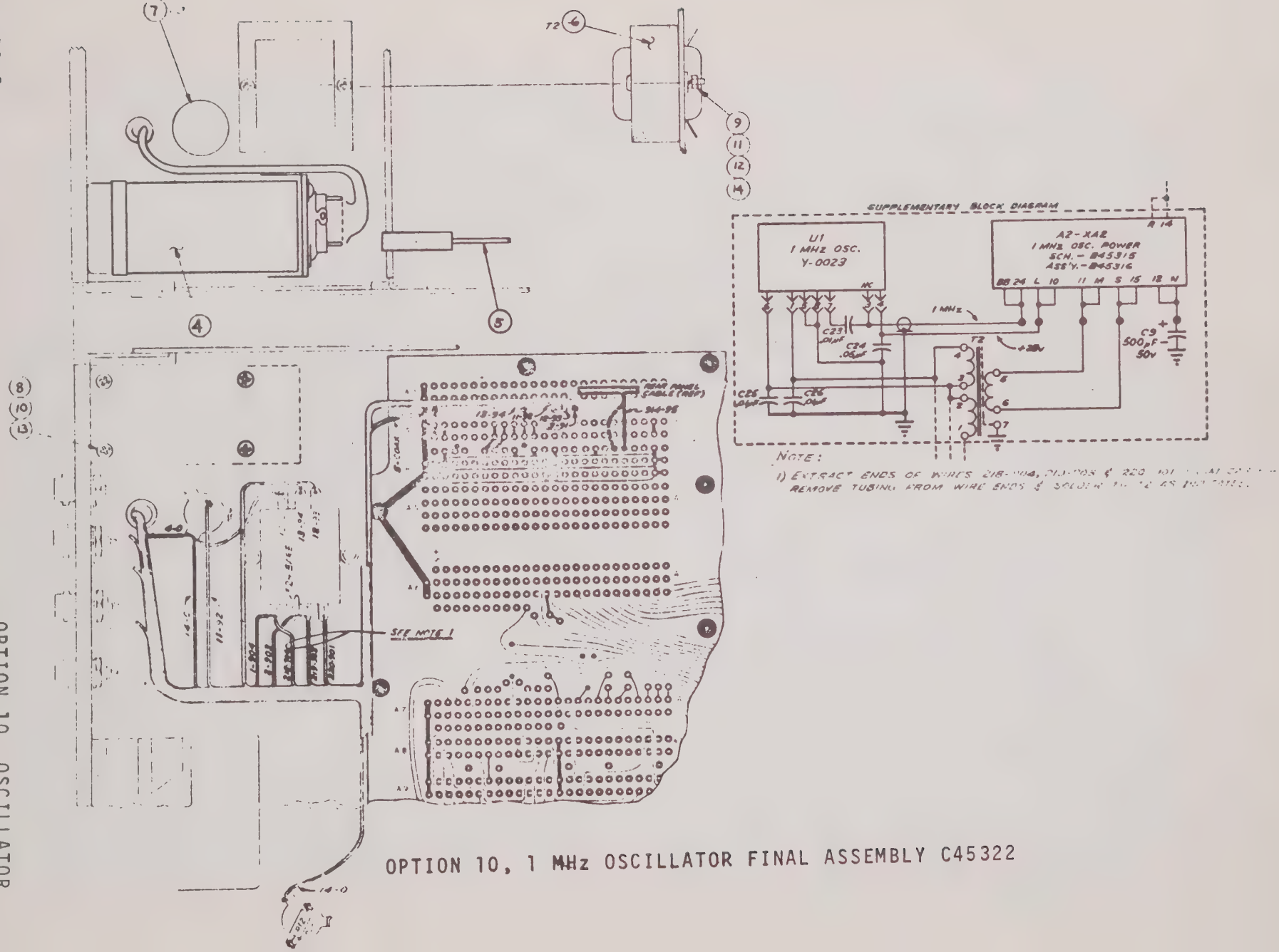
This oscillator option provides higher stability than the standard oscillator. The added assemblies include: U1, 1 MHz oscillator and A2, 1 MHz Oscillator Power Supply.

SPECIFICATIONS

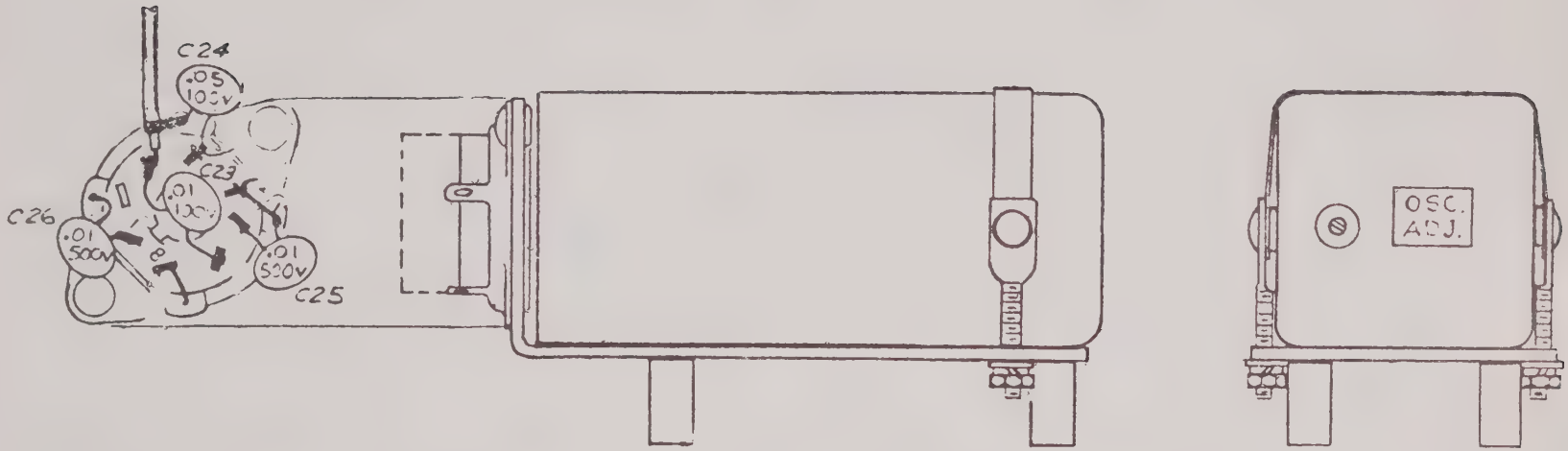
Aging rate after warm-up:	± 7 parts 10^9/24 hrs. ± 2 parts 10^8/24 hrs.
Maximum warm-up for "OFF" periods to 1 week:	30 days 72 hrs.
Frequency retrace for "OFF" periods up to approx. 24 hrs.:	72 hrs. typical to reach ± 2 parts 10^8.
Short-term aging rate:	± 5 parts 10^9 rms for 10 sec average.
Temperature variation:	± 5 parts 10^9/C° - 20 to 50°C.
± 10% change in line voltage from specified:	< ± 2 parts 10^8.
Long-term aging rate:	± 3 parts 10^9/24 hrs. after 45 days dynamic.

DRAWINGS

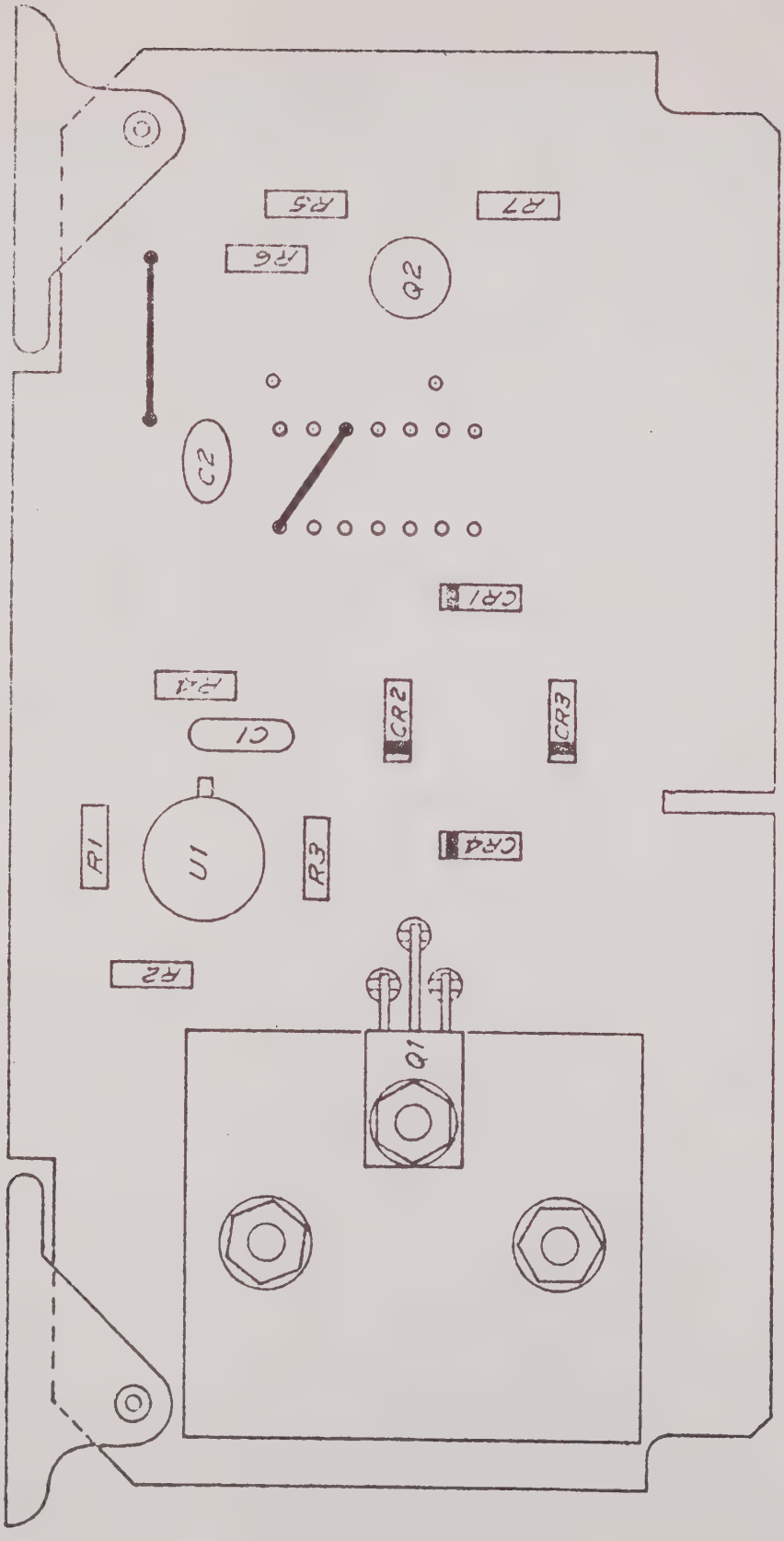
Option 10, 1 MHz Oscillator Final Assembly #C45322
Option 10, 1 MHz Oscillator Mtg. Bracket Assembly #B39161
Option 10, 1 MHz Oscillator Power Supply P.C. Assembly #B45316
Option 10, 1 MHz Oscillator Power Supply Schematic #B45315
Option 10, 1 MHz Oscillator Final Assembly Parts List #P/L45322



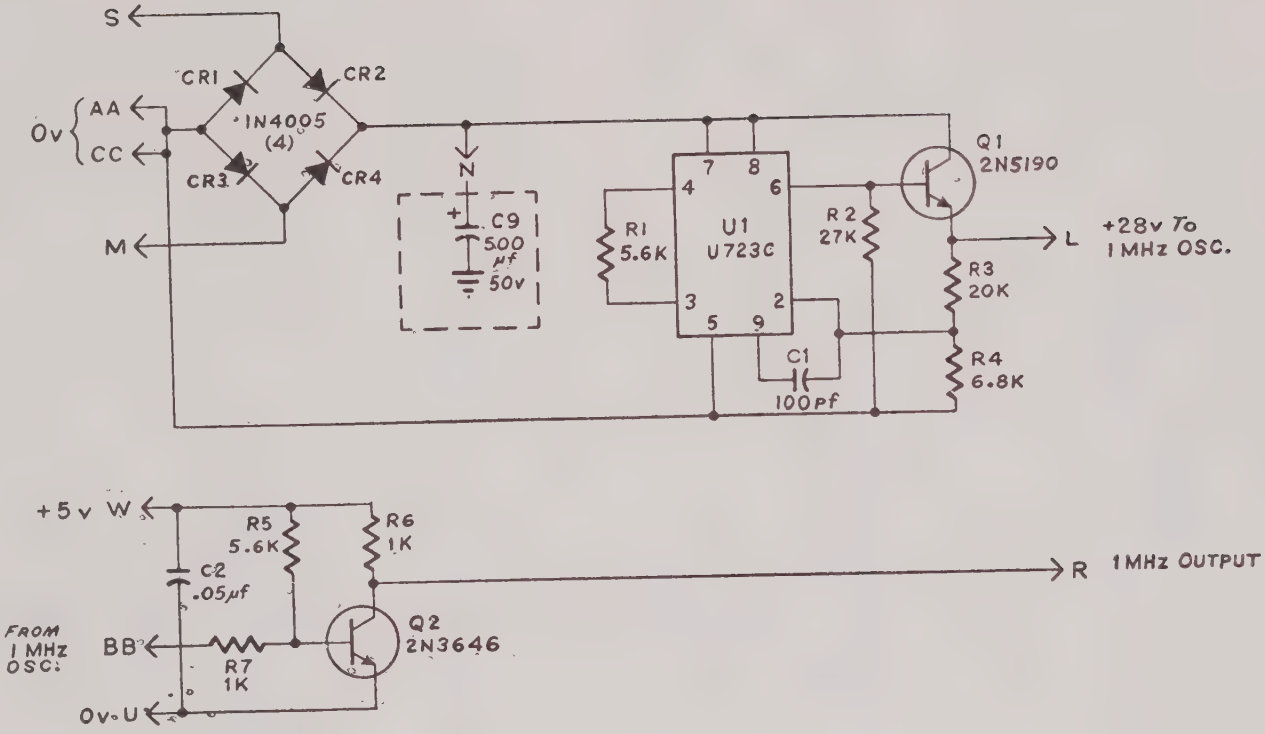
OPTION 10, 1 MHz OSCILLATOR FINAL ASSEMBLY C45322



OPTION 10, 1 MHz OSCILLATOR MTG. BRACKET ASSEMBLY B39161



OPTION 10, 1 MHz OSCILLATOR POWER SUPPLY P.C. ASSEMBLY B45316



NOTES: (UNLESS NOTED)

1. ALL RESISTORS: 1/4 W, 5%

OPTION 10, 1 MHz OSCILLATOR POWER SUPPLY SCHEMATIC #B45315

OPTION 10 OSCILLATOR FINAL ASSEMBLY PARTS LIST

Ref.	Description	SD Part No.
	Oscillator Option 10 Final Assembly	C45322
	ADD	
4	Oscillator Mounting Bracket Assembly	39161
A2	1 MHz Oscillator Power P.C. Assembly	B45316
T2	Transformer	B19805
C9	Capacitor, 500 µF, 50 V	03286060
	* * * * * * * * * * * * * * * * * * *	
	Oscillator Mounting Bracket Assembly	B39161
4	Oscillator Mounting Bracket	B39160
5	Oscillator Clamp Assembly	B39251
C23	Capacitor, .01 µF, 100 V	C0556
C24	Capacitor, .05 µF, 100 V	C0708
C25	Capacitor, .01 µF, 500 V	C0423
C26	Capacitor, .01 µF, 500 V	C0423
U1	Oscillator	Y0023
	* * * * * * * * * * * * * * * * * * *	
	1 MHz Oscillator Power P.C. Assembly	B45316
	1 MHz Oscillator Power P.C. Schematic	B45315
C1	Capacitor, 100 pF, 5%, 500 V	C0536
C2	Capacitor, .05 µF, 12 V	C0672
CR1	Diode, 1N4005, 500 V, 1 A	CR0284
CR2	Diode, 1N4005, 500 V, 1 A	CR0284
CR3	Diode, 1N4005, 500 V, 1 A	CR0284
CR4	Diode, 1N4005, 500 V, 1 A	CR0284
Q1	Transistor, 2N5190	Q0281
Q2	Transistor, 2N3646	Q0218
R1	Resistor, 5.6 k, 5%, 1/4 W	R0821
R2	Resistor, 27 k, 5%, 1/4 W	R0824
R3	Resistor, 20 k, 5%, 1/4 W	R0964
R4	Resistor, 6.8 k, 5%, 1/4 W	R0696
R5	Resistor, 5.6 k, 5%, 1/4 W	R0821
R6	Resistor, 1 k, 5%, 1/4 W	R0765
R7	Resistor, 1 k, 5%, 1/4 W	R0765
U1	Integrated Circuit, U723C	25756

OPTION 11
OSCILLATOR

DESCRIPTION

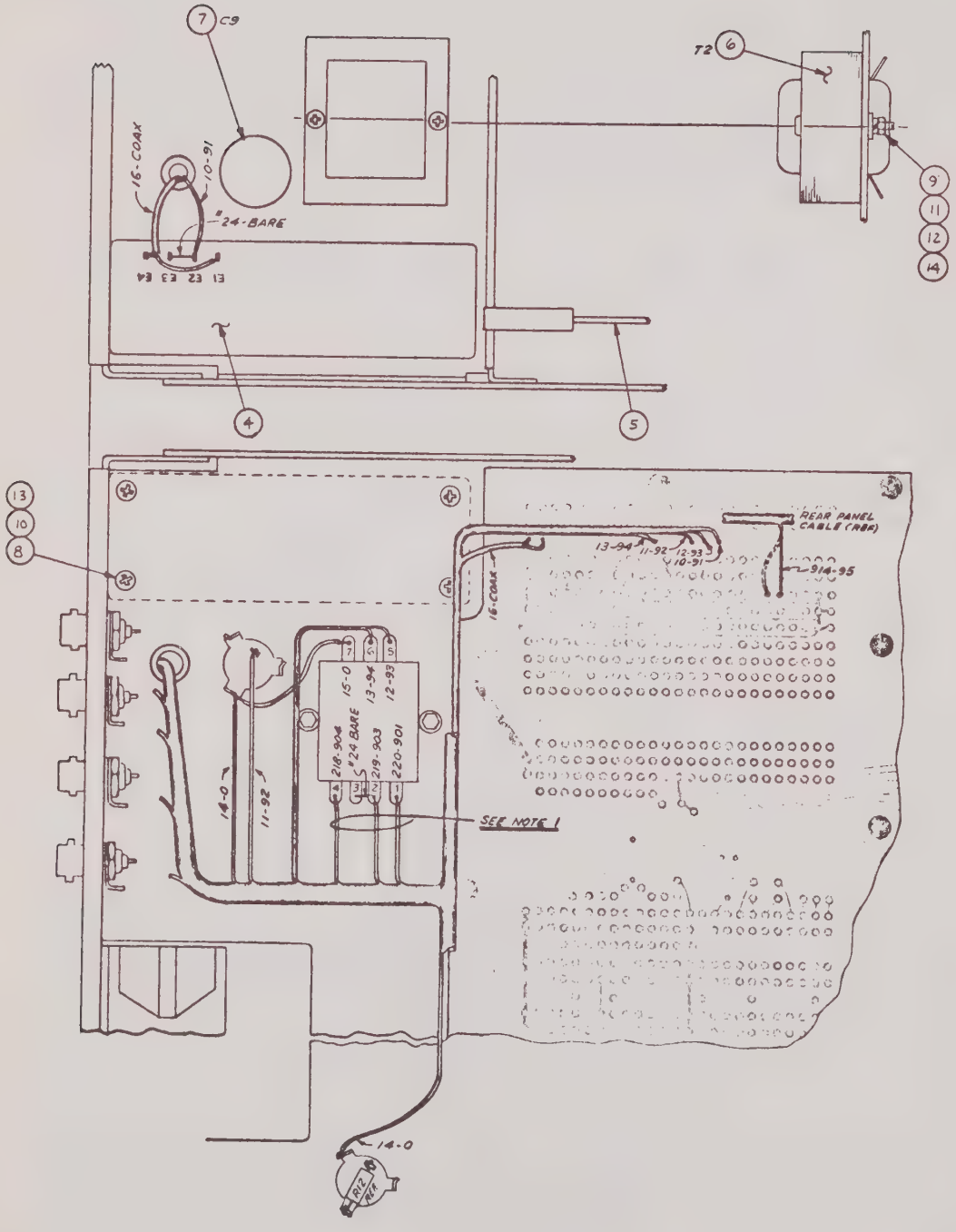
This oscillator option provides higher stability than the standard oscillator. The added assemblies include: U1, 3 MHz Oscillator and A2, 3 MHz Oscillator Power Supply.

SPECIFICATIONS

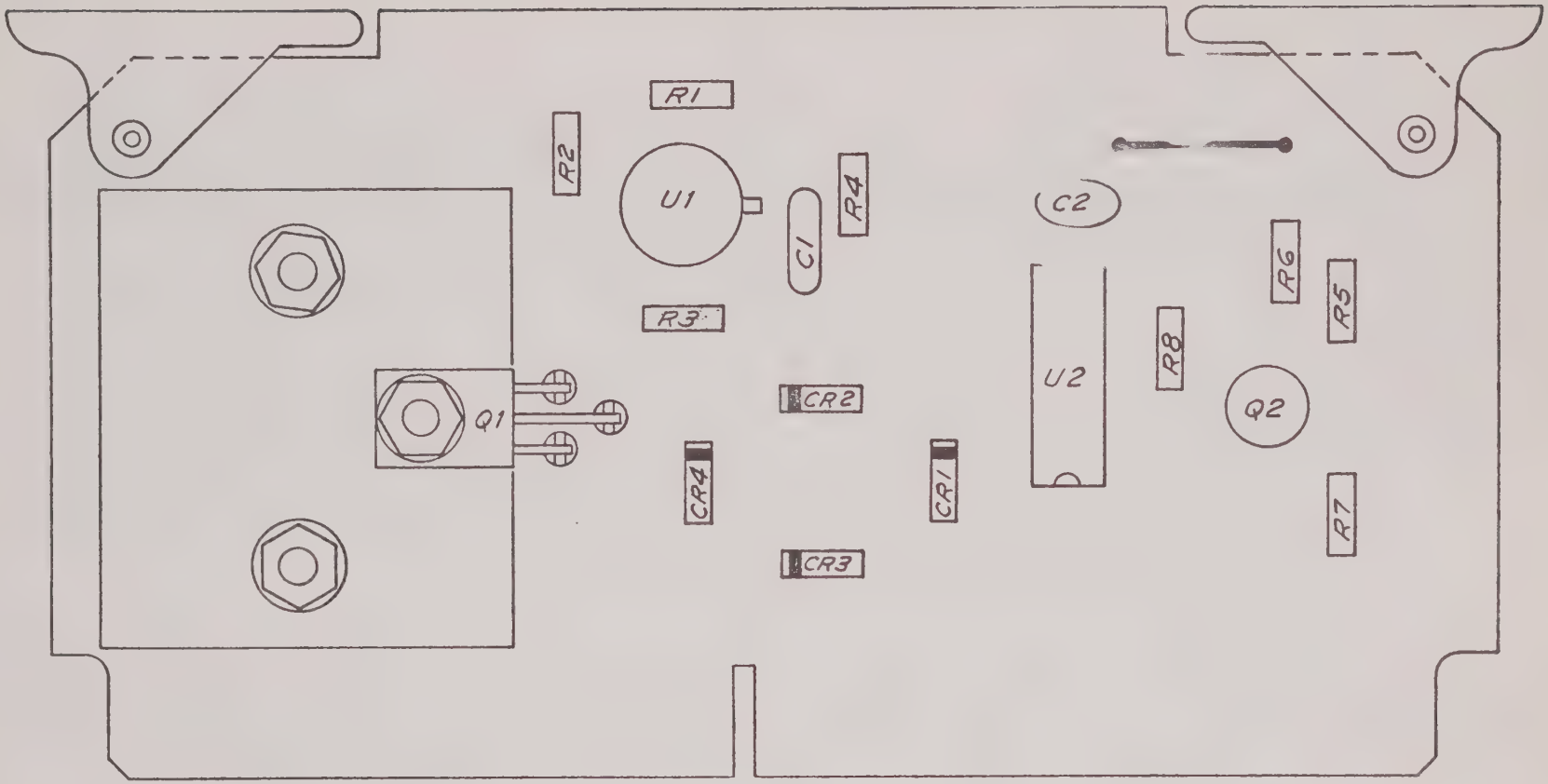
Aging rate after warm-up:	±3 parts 10^9/24 hrs.
Maximum warm-up for "OFF" periods to 1 week:	72 hrs.
Frequency retrace for "OFF" periods up to approx. 24 hrs.:	1 hr. typical to reach ±6 parts 10^8 maximum.
Short-term aging rate:	±1 part 10^{10} rms for 1 sec average.
Temperature variation:	<±2 parts 10^{10}/C°, typical (max. ±4 parts in 10^9 over 20° change within -20° to 50°C).
±10% change in line voltage from specified:	±5 parts 10^{10}.
Long-term aging rate:	±3 parts 10^8/30 days.

DRAWINGS

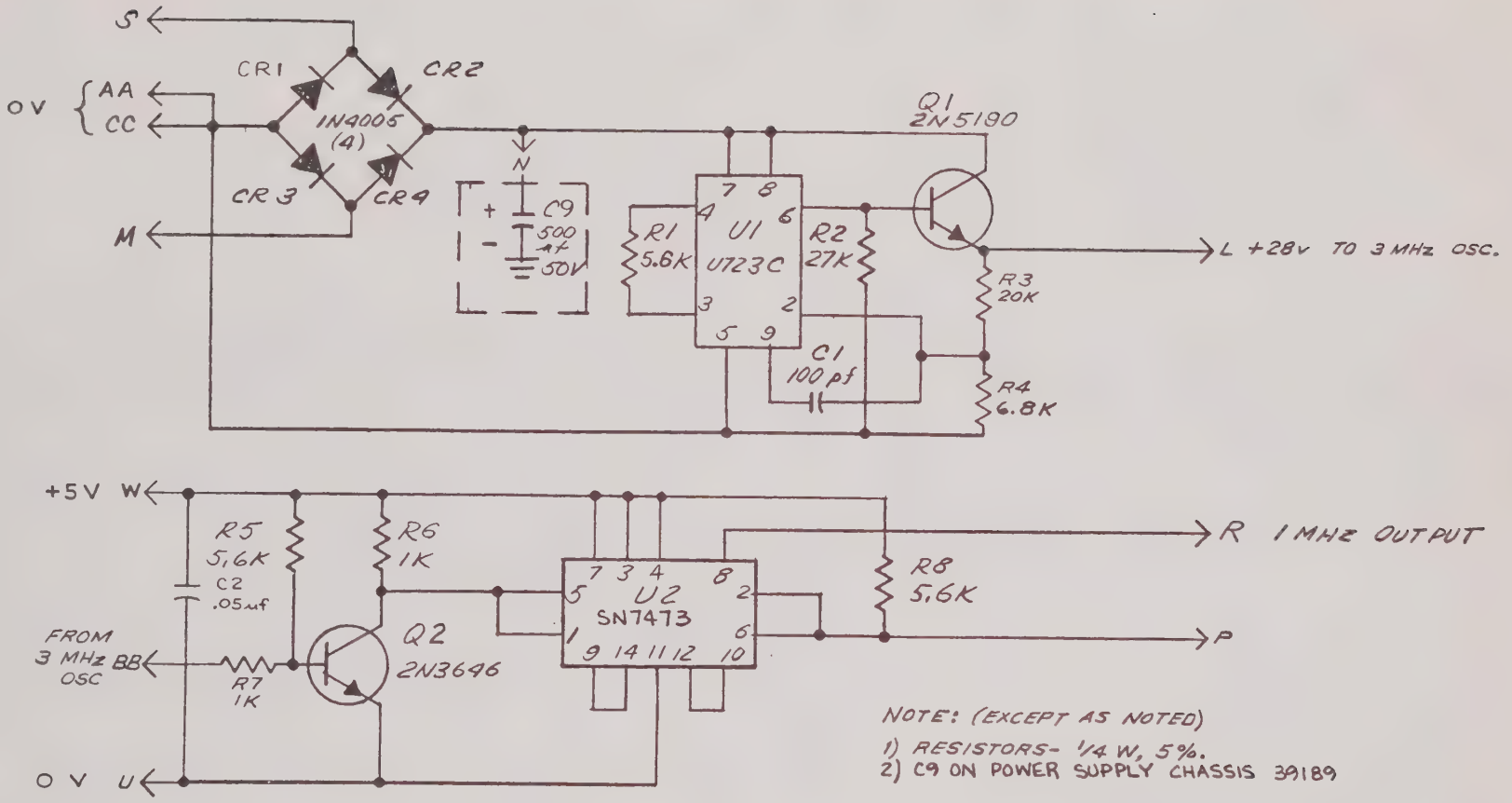
Option 11, 3 MHz Oscillator Final Assembly #C45319
Option 11, 3 MHz Oscillator Power Supply P.C. Assembly #B39367
Option 11, 3 MHz Oscillator Power Supply Schematic #B39364
Option 11, 3 MHz Oscillator Final Assembly Parts List #P/L45319



OPTION 11, 3 MHz OSCILLATOR FINAL ASSEMBLY C45319



OPTION 11, 3 MHz OSCILLATOR POWER SUPPLY P.C. ASSEMBLY B39367



OPTION 11, 3 MHz OSCILLATOR POWER SUPPLY SCHEMATIC B39364

OPTION 11 OSCILLATOR FINAL ASSEMBLY PARTS LIST

Ref.	Description	SD Part No.
	Option 11 Oscillator Final Assembly	C45319
	ADD	
A2	See 3 MHz Oscillator Power P.C. Assembly	B39367
C9	Capacitor, 500 µF, 500 V	03286060
T2	Transformer	B19805
U1	Oscillator	C33428

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3 MHz OSCILLATOR POWER P.C. ASSEMBLY

Ref.	Description	SD Part No.
	3 MHz Oscillator Power P.C. Assembly	B39367
	3 MHz Oscillator Power P.C. Schematic	B39364
C1	Capacitor, 100 pF, 5%, 500 V	C0536
C2	Capacitor, .05 µF, 12 V	C0672
CR1	Diode, 1N4005, 600 V, 1 A	CR0284
CR2	Diode, 1N4005, 600 V, 1 A	CR0284
CR3	Diode, 1N4005, 600 V, 1 A	CR0284
CR4	Diode, 1N4005, 600 V, 1 A	CR0284
Q1	Transistor, 2N5190	Q0281
Q2	Transistor, 2N3646	Q0218
R1	Resistor, 5.6 k, 5%, 1/4 W	R0821
R2	Resistor, 27 k, 5%, 1/4 W	R0824
R3	Resistor, 20 k, 5%, 1/4 W	R0964
R4	Resistor, 6.8 k, 5%, 1/4 W	R0696
R5	Resistor, 5.6 k, 5%, 1/4 W	R0821
R6	Resistor, 1 k, 5%, 1/4 W	R0765
R7	Resistor, 1 k, 5%, 1/4 W	R0765
R8	Resistor, 5.6 k, 5%, 1/4 W	R0821
U1	Integrated Circuit, U723C	25756
U2	Integrated Circuit, 7473N	19709

OPTION 12
OSCILLATOR

DESCRIPTION

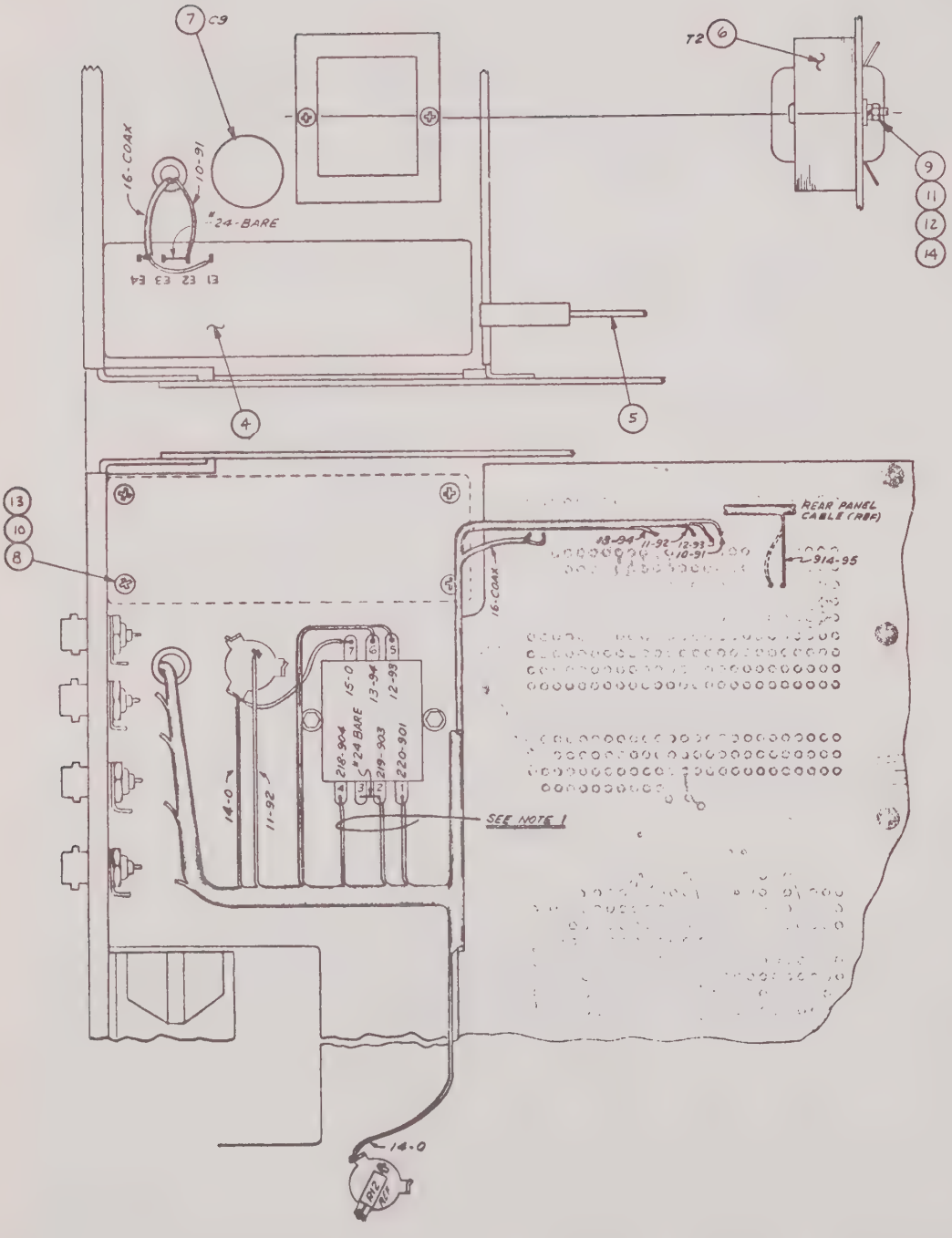
This oscillator option provides higher stability than the standard oscillator. The added assemblies include: U1, 3 MHz Oscillator and A2, 3 MHz Oscillator Power Supply.

SPECIFICATIONS

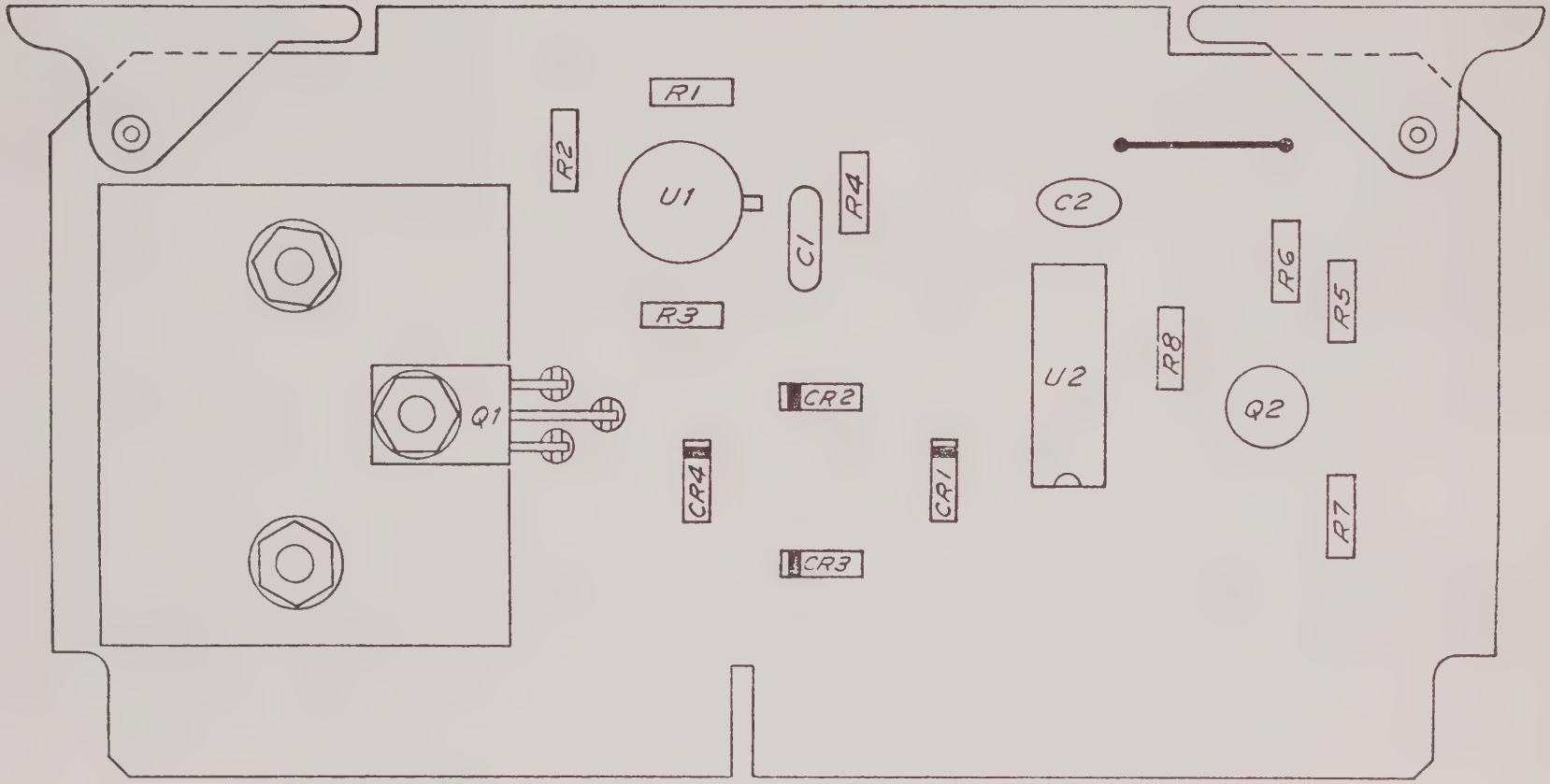
Aging rate after warm-up:	$<\pm 1$ part 10^9/24 hrs.
Maximum warm-up for "OFF" periods to 1 week:	72 hrs.
Frequency retrace for "OFF" periods up to approx. 24 hrs.:	1 hr. typical to reach ± 6 parts 10^8 maximum.
Short-term aging rate:	± 1 part 10^{10} rms for 1 sec average.
Temperature variation:	$<\pm 2$ parts 10^{10}/C°, typical (max. ± 4 parts in 10^9 over 20° change within -20° to 50°C).
±10% change in line voltage from specified:	± 5 parts 10^{10}.
Long-term aging rate:	± 3 parts 10^8/30 days.

DRAWINGS

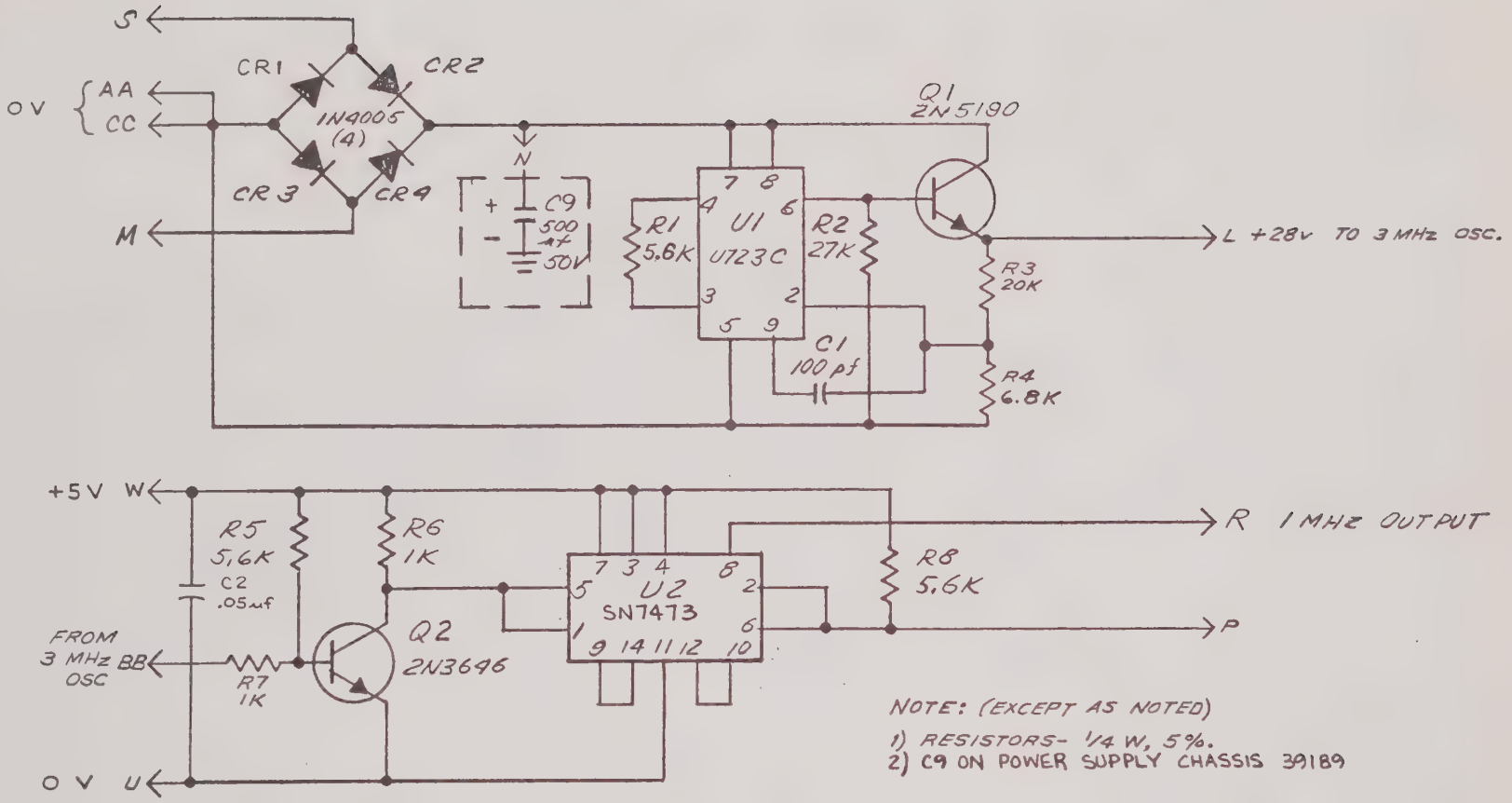
Option 12, 3 MHz Oscillator Final Assembly #C45383
Option 12, 3 MHz Oscillator Power Supply P.C. Assembly #B39367
Option 12, 3 MHz Oscillator Power Supply Schematic #B39364
Option 12, 3 MHz Oscillator Final Assembly Parts List #P/L45383



OPTION 12, 3 MHz OSCILLATOR FINAL ASSEMBLY #C45383



OPTION 12, 3 MHz OSCILLATOR POWER SUPPLY P.C. ASSEMBLY #B39367



OPTION 12, 3 MHz OSCILLATOR POWER SUPPLY SCHEMATIC #B39364

OPTION 12 OSCILLATOR FINAL ASSEMBLY PARTS LIST

Ref.	Description	SD Part No.
	Option 12 Oscillator Final Assembly	C45383
	ADD	
A2	See 3 MHz Oscillator Power P.C. Assembly	B39367
C9	Capacitor, 500 µF, 50 V	02386060
T2	Transformer	B19805
U1	Oscillator	C33427

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3 MHz OSCILLATOR POWER SUPPLY P.C. ASSEMBLY

Ref.	Description	SD Part No.
	3 MHz Oscillator Power P.C. Assembly	B39367
	3 MHz Oscillator Power P.C. Schematic	B39364
C1	Capacitor, 100 pF, 5%, 500 V	C0536
C2	Capacitor, .05 µF, 12 V	C0672
CR1	Diode, 1N4005, 600 V, 1 A	CR0284
CR2	Diode, 1N4005, 600 V, 1 A	CR0284
CR3	Diode, 1N4005, 600 V, 1 A	CR0284
CR4	Diode, 1N4005, 600 V, 1 A	CR0284
Q1	Transistor, 2N5190	Q0281
Q2	Transistor, 2N3646	Q0218
R1	Resistor, 5.6 k, 5%, 1/4 W	R0821
R2	Resistor, 27 k, 5%, 1/4 W	R0824
R3	Resistor, 20 k, 5%, 1/4 W	R0964
R4	Resistor, 6.8 k, 5%, 1/4 W	R0696
R5	Resistor, 5.6 k, 5%, 1/4 W	R0821
R6	Resistor, 1 k, 5%, 1/4 W	R0765
R7	Resistor, 1 k, 5%, 1/4 W	R0765
R8	Resistor, 5.6 k, 5%, 1/4 W	R0821
U1	Integrated Circuit, U723C	25756
U2	Integrated Circuit, 7473N	19709

OPTION 13
OSCILLATOR

DESCRIPTION

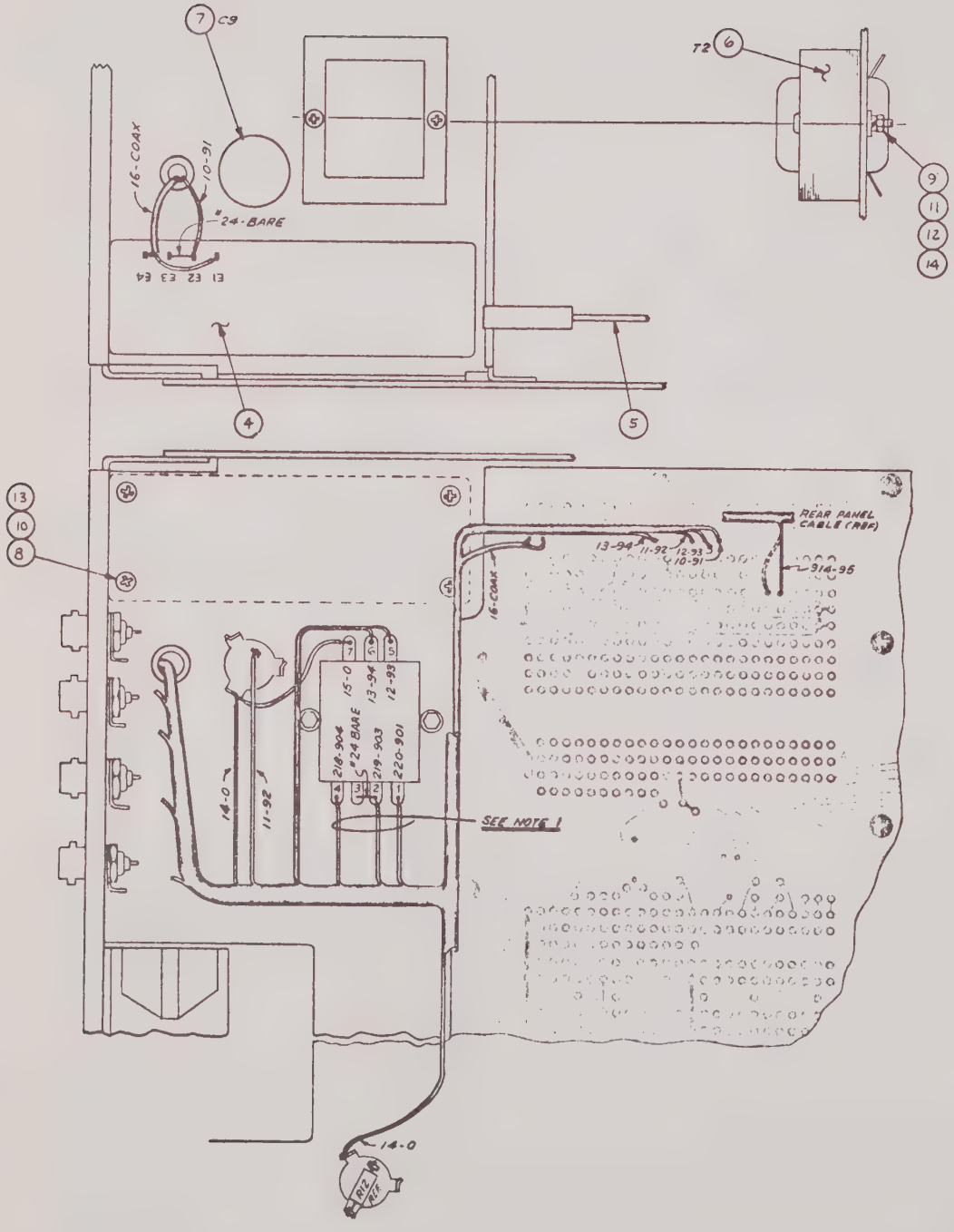
This oscillator option provides higher stability than the standard oscillator. The added assemblies include: U1, 3 MHz Oscillator and A2, 3 MHz Oscillator Power Supply.

SPECIFICATIONS

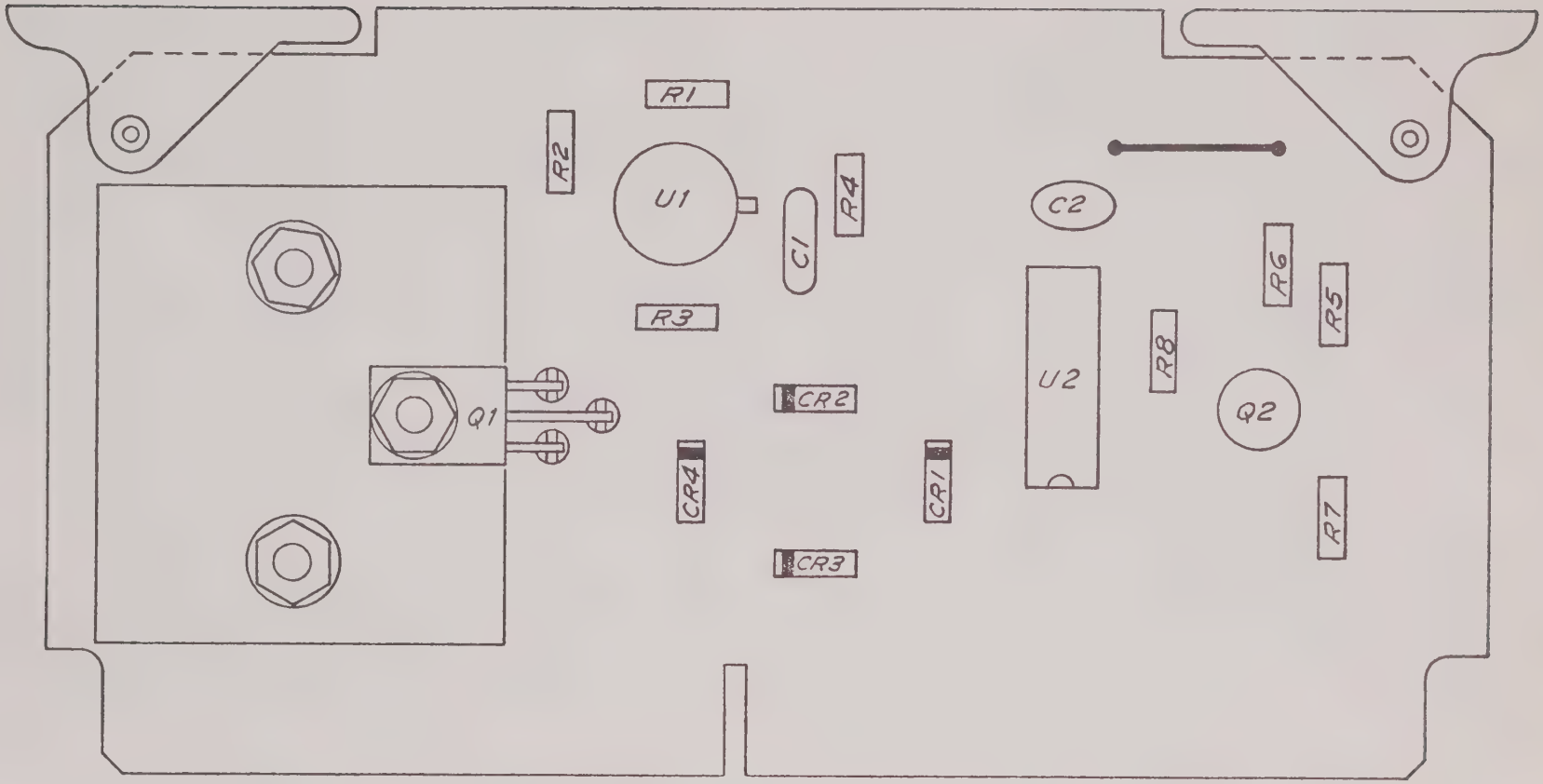
Aging rate after warm-up:	±5 parts 10^{10}/24 hrs.
Maximum warm-up for "OFF" periods to 1 week:	72 hrs.
Frequency retrace for "OFF" periods up to approx. 24 hrs.:	1 hr. typical to reach <±5 parts 10^{9}.
Short-term aging rate:	±5 parts 10^{11} rms for 1 sec average.
Temperature variation:	<±2 parts 10^{10}/C°, typical (max. ±4 parts in 10^{9} over 20° change within -20° to 50°C).
±10% change in line voltage from specified:	±5 parts 10^{11}.
Long-term aging rate:	±1.5 parts 10^{8}/30 days.

DRAWINGS

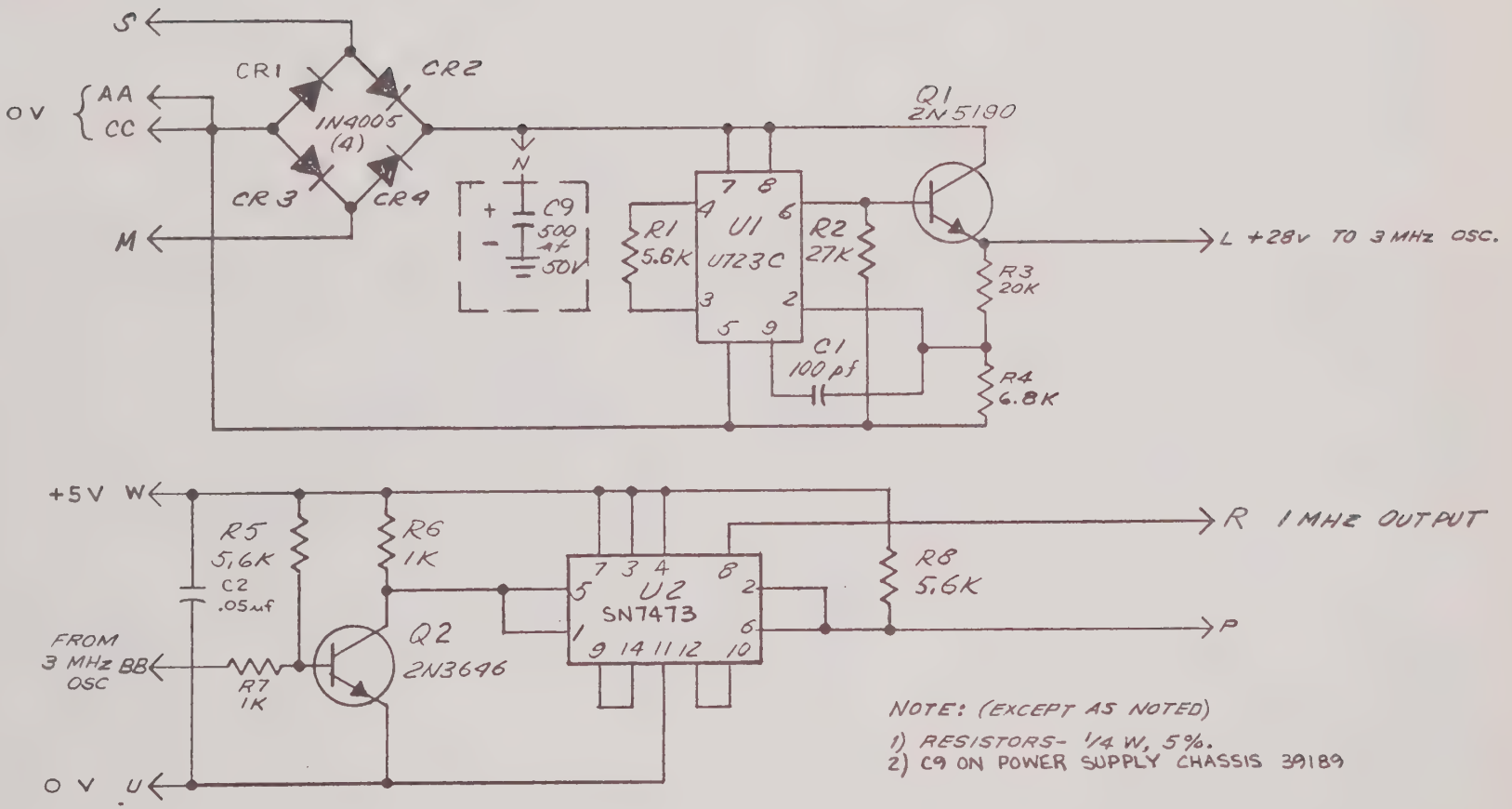
Option 13, 3 MHz Oscillator Final Assembly #C45384
Option 13, 3 MHz Oscillator Power Supply P.C. Assembly #B39367
Option 13, 3 MHz Oscillator Power Supply Schematic #B39364
Option 13, 3 MHz Oscillator Final Assembly Parts List #P/L45384



OPTION 13, 3 MHz OSCILLATOR FINAL ASSEMBLY #C45384



OPTION 13, 3 MHz OSCILLATOR POWER SUPPLY P.C. ASSEMBLY #B39367



OPTION 13, 3 MHz OSCILLATOR POWER SUPPLY SCHEMATIC #B39364

OPTION 13 OSCILLATOR FINAL ASSEMBLY PARTS LIST

Ref.	Description	SD Part No.
	Option 13 Oscillator Final Assembly	C45384
	ADD	
A2	See 3 MHz Oscillator Power P.C. Assembly	B39367
C9	Capacitor, 500 µF, 50 V	03286060
T2	Transformer	B19805
U1	Oscillator	C33429

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3 MHz OSCILLATOR POWER P.C. ASSEMBLY

Ref.	Description	SD Part No.
	3 MHz Oscillator Power P.C. Assembly	B39367
	3 MHz Oscillator Power P.C. Schematic	B39364
C1	Capacitor, 100 pF, 5%, 500 V	C0536
C2	Capacitor, .05 µF, 12 V	C0672
CR1	Diode, 1N4005, 600 V, 1 A	CR0284
CR2	Diode, 1N4005, 600 V, 1 A	CR0284
CR3	Diode, 1N4005, 600 V, 1 A	CR0284
CR4	Diode, 1N4005, 600 V, 1 A	CR0284
Q1	Transistor, 2N5190	Q0281
Q2	Transistor, 2N3646	Q0218
R1	Resistor, 5.6 k, 5%, 1/4 W	R0821
R2	Resistor, 27 k, 5%, 1/4 W	R0824
R3	Resistor, 20 k, 5%, 1/4 W	R0964
R4	Resistor, 6.8 k, 5%, 1/4 W	R0696
R5	Resistor, 5.6 k, 5%, 1/4 W	R0821
R6	Resistor, 1 k, 5%, 1/4 W	R0765
R7	Resistor, 1 k, 5%, 1/4 W	R0765
R8	Resistor, 5.6 k, 5%, 1/4 W	R0821
U1	Integrated Circuit, U723C	25756
U2	Integrated Circuit, 7473N	19709

OPTION 15
ONE ADDED READOUT DIGIT

This option adds one (1) readout digit to the left hand, most significant digit position on the A1, Readout P.C. board.

Reference Drawings:

A1, Readout P.C. Assembly #C39383 (see text)
A1, Readout Schematic #E39380 (see text)
Option 15, Final Assembly Parts List #P/L45482

OPTION 15 FINAL ASSEMBLY (8 DIGIT) PARTS LIST

Ref.	Description	SD Part No.
	Option 15 Final Assembly (8 Digit)	P/L45482
U8	Integrated Circuit, SN74141N	25730
U18	Integrated Circuit, SN7475N	19710
U26	Integrated Circuit, SN7490N	25732
V8	Readout Tube, NL58595	V0131
XV8	Socket Readout Tube	X0179

OPTION 16
TWO ADDED READOUT DIGITS

This option adds two (2) readout digits to the left hand, most significant digit position on the A1, Readout P.C. Board.

DRAWINGS

A1, Readout P.C. Assembly #C39383 (see text)
A1, Readout Schematic #E39380 (see text)
Option 16, Final Assembly Parts List #P/L45483

OPTION 16 FINAL ASSEMBLY (9 DIGIT) PARTS LIST

Ref.	Description	SD Part No.
	Option 16 Final Assembly (9 Digit)	P/L45483
U8	Integrated Circuit, SN74141N	25730
U9	Integrated Circuit, SN74141N	25730
U18	Integrated Circuit, SN7475N	19710
U19	Integrated Circuit, SN7475N	19710
U26	Integrated Circuit, SN7490N	25732
U27	Integrated Circuit, SN7490N	25732
V8	Readout Tube, NL5859S	V0131
V9	Readout Tube, NL5859S	V0131
XV8	Socket, Readout Tube	X0179
XV9	Socket, Readout Tube	X0179

OPTION 20
REMOTE PROGRAMMING
(All Controls, Group Binary, Ground True)

DESCRIPTION

This Option provides remote control of all switchable front panel controls, with the exception of the POWER switch, in a group binary format. The remote control circuits use ground "0" to operate the functions. REMOTE connector J14 is a 50 pin Amphenol 57-40500

REMOTE PIN ASSIGNMENTS

PIN	FUNCTION
38	A x 1
37	A x 10
leave 38 and 37 open	A x 100
36	A-DC
34	B x 1
33	B x 10
leave 34 and 33 open	B x 100
32	B-DC
31	B (SLOPE)
30	C x 1
29	C x 10
leave 30 and 29 open	C x 100
28	C-DC
27	C (SLOPE)
35	B+C COM.
50	REMOTE/LOCAL
26	GND
5	"0" = TEST
4	"0" = FAST/"1" = SLOW
3	"0" = RATIO
2	"0" = RESET
6	RESOLUTION CODE
7	RESOLUTION CODE
8	RESOLUTION CODE
9	RESOLUTION CODE
10	FUNCTION CODE
11	FUNCTION CODE
12	FUNCTION CODE
13	FUNCTION CODE

REMOTE PIN ASSIGNMENTS (Cont'd)

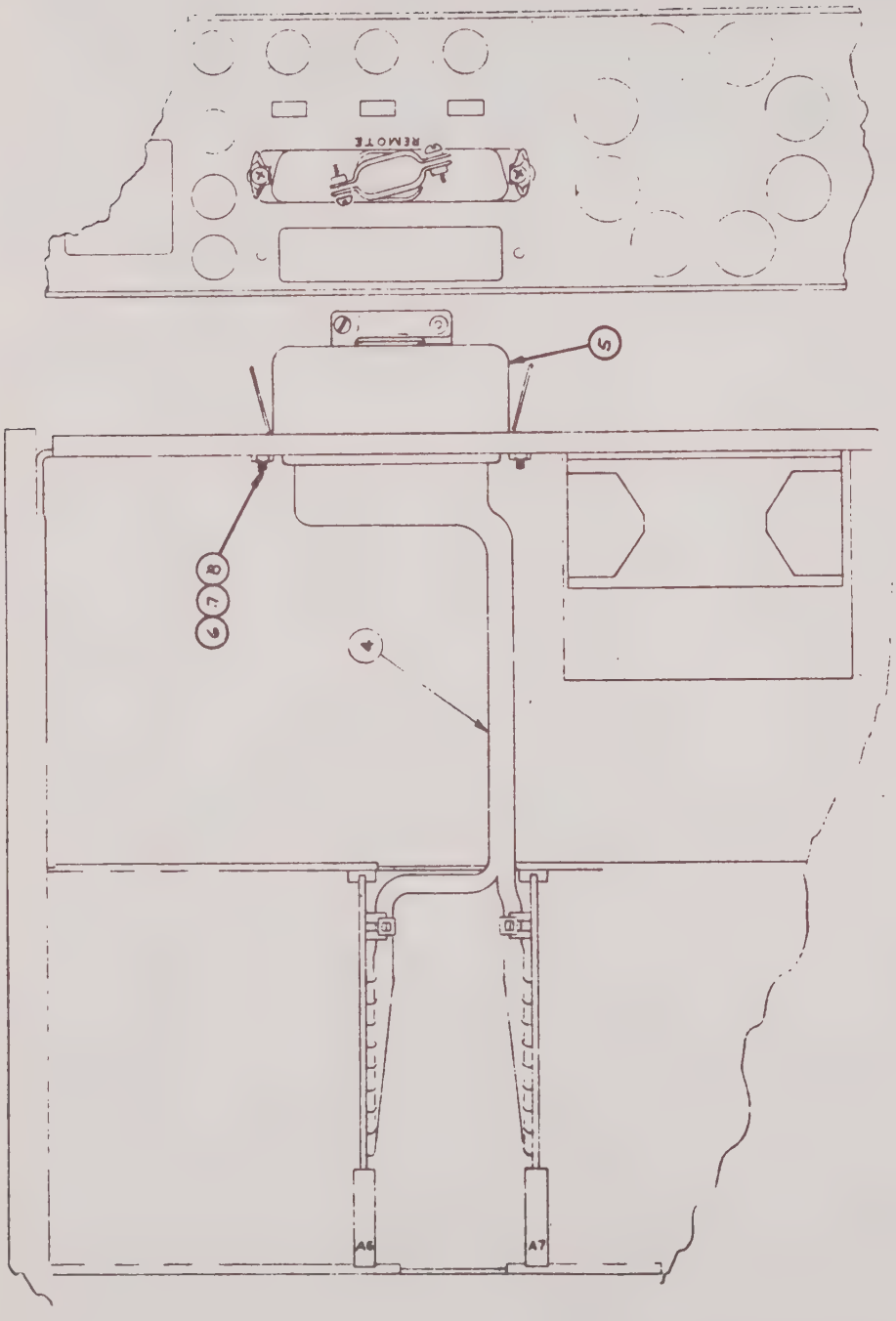
PIN	FUNCTION
25	REMOTE/LOCAL
1	GND

RESOLUTION CODE	PIN NO. 6	7	8	9
.1 Hz	1	1	1	1
1 SEC	1	1	1	0
100 ms	1	1	0	1
10 ms	1	1	0	0
1 ms	1	0	1	1
100 µs	1	0	1	0
10 µs	1	0	0	1
1 µs	1	0	0	0
100 ns	0	1	1	1
10 ns	0	1	1	0

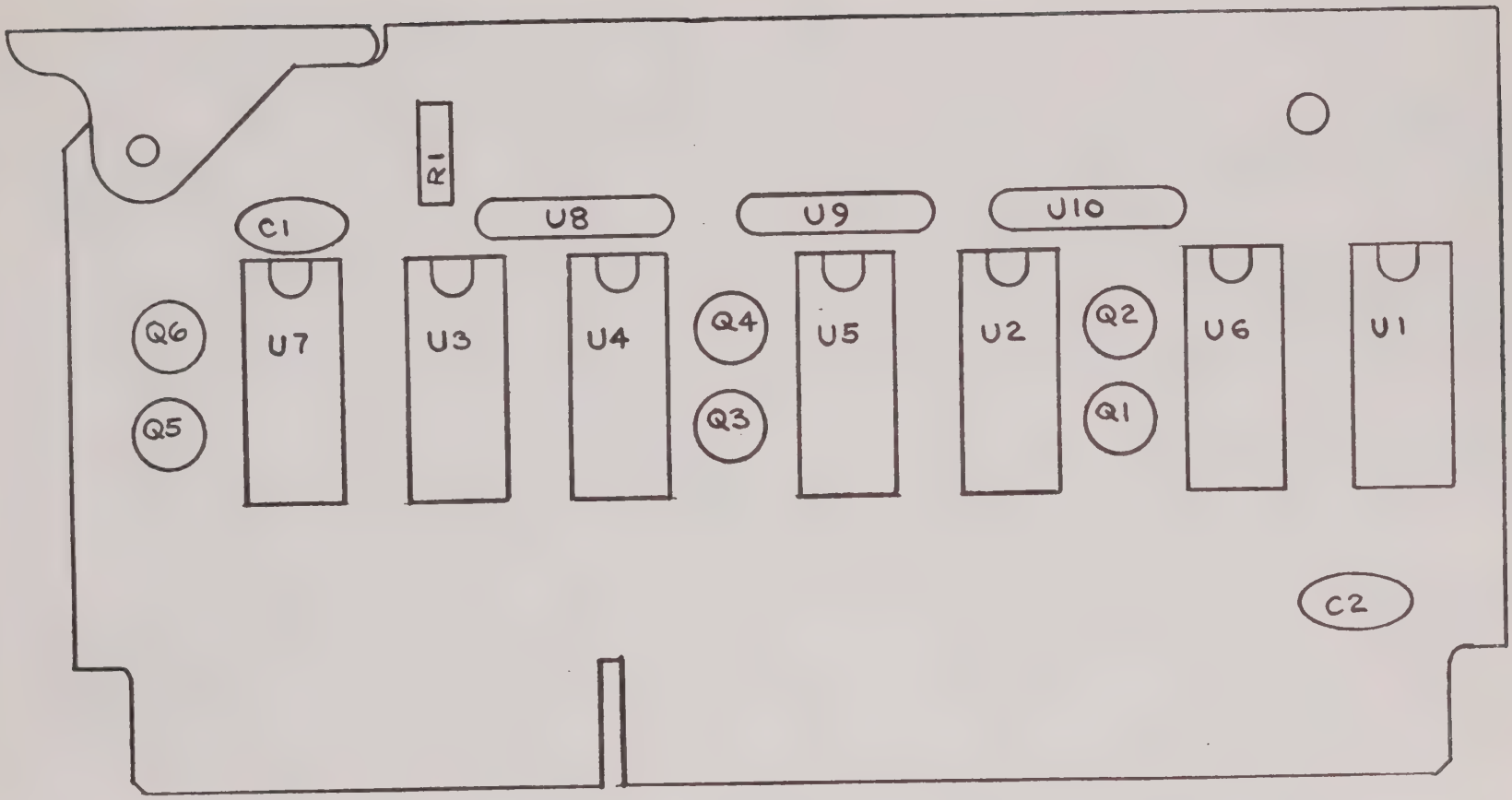
FUNCTION CODE	PIN NO. 10	11	12	13
TIM	1	1	1	1
RATE D	1	1	1	0
RATE A	1	1	0	1
COUNT A	1	1	0	0
HOLD	1	0	1	1
P/R x 1	1	0	1	0
P/R x 10	1	0	0	1
P/R x 10^2	1	0	0	0
P/R x 10^3	0	1	1	1
P/R x 10^4	0	1	1	0
P/R x 10^5	0	1	0	1

DRAWINGS

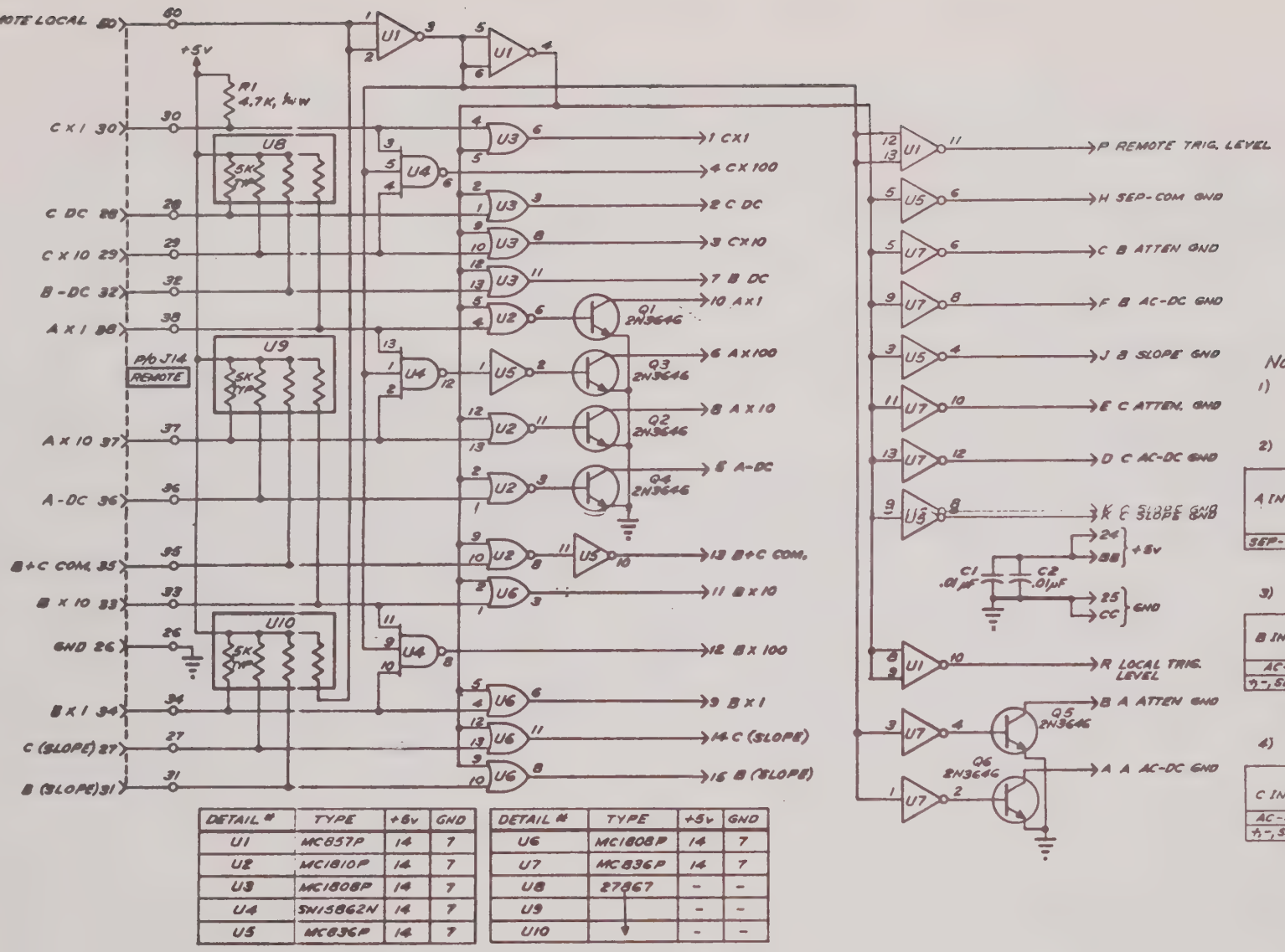
Option 20, Final Assembly #C45356
Option 20, A6, Binary Attenuator Select P.C. Assembly #C39756
Option 20, A6, Binary Attenuator Select Schematic #C39753
Option 20, A7, Binary Function Select P.C. Assembly #C39760
Option 20, A7, Binary Function Select Schematic #C39757
Option 20, Final Assembly Parts List #P/L45356



OPTION 20, FINAL ASSEMBLY #C45356



OPTION 20, A6, BINARY ATTENUATOR SELECT P.C. ASSEMBLY #C39756



DETAIL #	TYPE	+5V	GND
U1	MC857P	14	7
U2	MC1810P	14	7
U3	MC1808P	14	7
U4	SN15862N	14	7
U5	MC836P	14	7

DETAIL #	TYPE	+5V	GND
U6	MC1808P	14	7
U7	MC836P	14	7
U8	27867	-	-
U9	↓	-	-
U10		-	-

NOTE:
1) 1 = +5V = LOCAL
0 = 0.0V = REMOTE

2)

		PIN # 38	37	36	35
A INPUT	X1	0	1		
	X10	1	0		
	X100	1	1		
	DC			0	
SEP-COM	COM				0

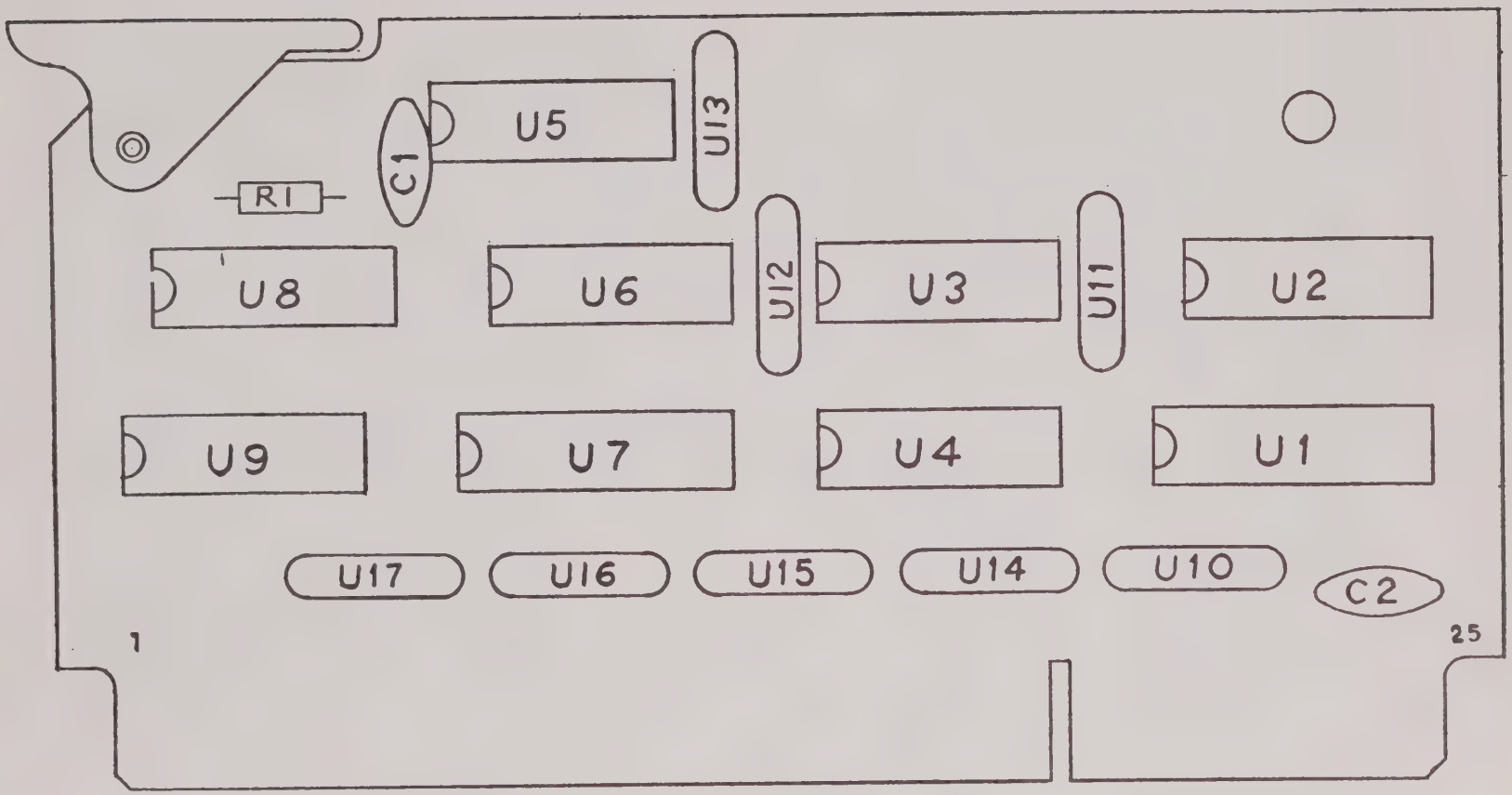
3)

		PIN # 34	33	32	31
B INPUT	X1	0	1		
	X10	1	0		
	X100	1	1		
AC-DC	DC			0	
+/-, SLOPE	+				0

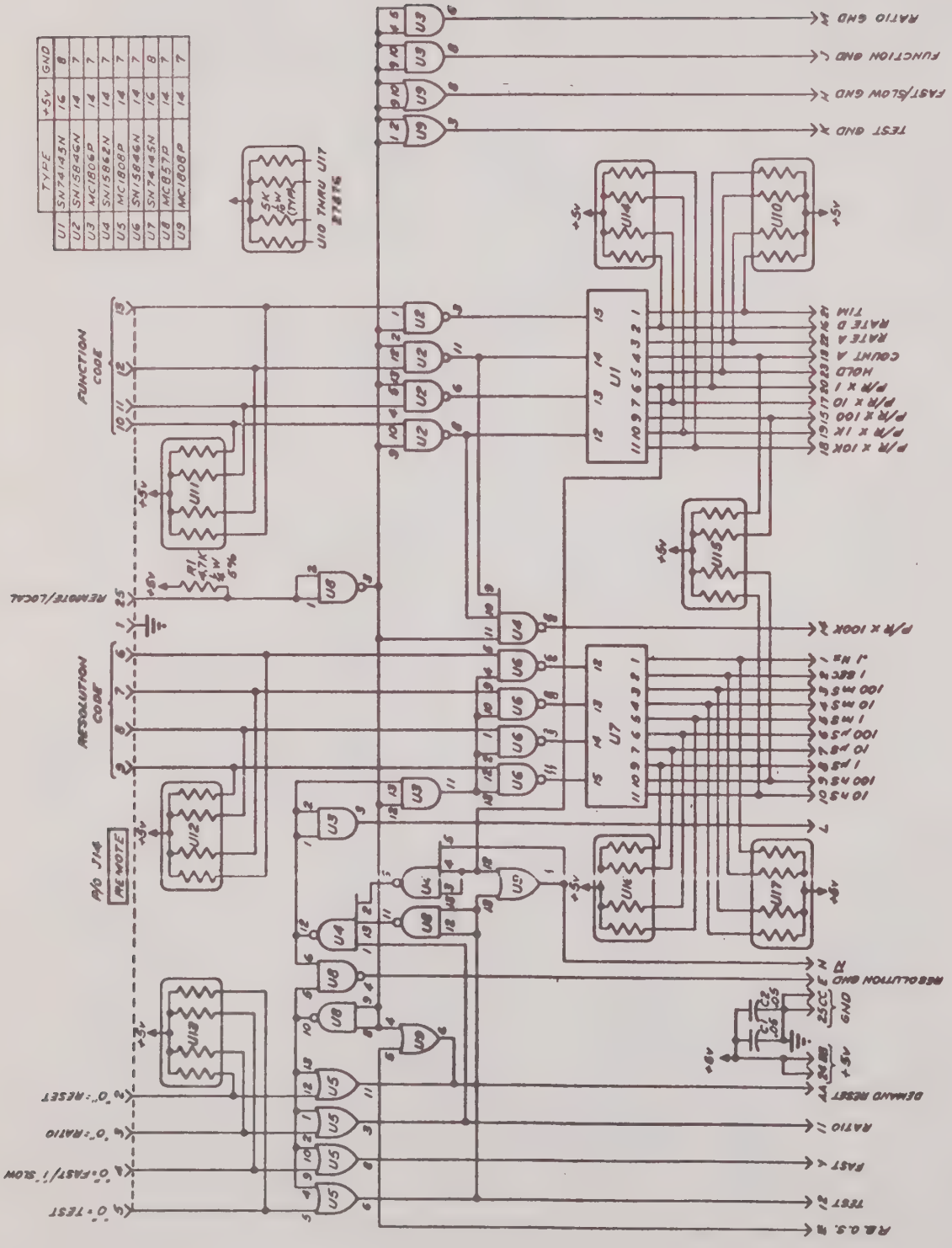
4)

		PIN # 30	29	28	27
C INPUT	X1	0	1		
	X10	1	0		
	X100	1	1		
AC-DC	DC			0	
+/-, SLOPE	+				0

OPTION 20, A6, BINARY ATTENUATOR SELECT SCHEMATIC #C39753



OPTION 20, A7, BINARY FUNCTION SELECT P.C. ASSEMBLY #C39760



OPTION 20, A7, BINARY FUNCTION SELECT SCHEMATIC #C39757

OPTION 20 FINAL ASSEMBLY PARTS LIST

Ref.	Description	SD Part No.
	Option 20 Final Assembly	C45356
	ADD	
4	Binary Remote Assembly consisting of:	C45355
6	Binary Remote Cable Assembly	B45354
4	Binary Attenuator Select P.C. Assembly	C39756
5	Binary Function Select P.C. Assembly	C39760
P14	Connector, w/hood, 50 pin	J0171
	* * * * * * * * * * * * * * * * * * * *	
	Binary Remote Cable Assembly	35354
J14	Connector, 50 pin	J0170
	* * * * * * * * * * * * * * * * * * * *	
A6	Binary Attenuator Select P.C. Assembly	C39756
A6	Binary Attenuator Select P.C. Schematic	C39753
C1	Capacitor, .05 µF, 12 V	C0672
C2	Capacitor, .05 µF, 12 V	C0672
Q1	Transistor, 2N3646	Q0218
Q2	Transistor, 2N3646	Q0218
Q3	Transistor, 2N3646	Q0218
Q4	Transistor, 2N3646	Q0218
Q5	Transistor, 2N3646	Q0218
Q6	Transistor, 2N3646	Q0218
R1	Resistor, 4.7 k, 5%, 1/4 W	R0892
U1	Integrated Circuit, MC857P	25753
U2	Integrated Circuit, MC1810P	25735
U3	Integrated Circuit, MC1808P	25734
U4	Integrated Circuit, SN15862N	19719
U5	Integrated Circuit, MC836P	25704
U6	Integrated Circuit, MC1808P	25734
U7	Integrated Circuit, MC836P	25704
U8	Resistor Network, 5 k, 1/10 W	A27867
U9	Resistor Network, 5 k, 1/10 W	A27867
U10	Resistor Network, 5 k, 1/10 W	A27867
	* * * * * * * * * * * * * * * * * * * *	

OPTION 20 FINAL ASSEMBLY PARTS LIST (Cont'd)

Ref.	Description	SD Part No.
A7	Binary Function Select P.C. Assembly	C39760
A7	Binary Function Select P.C. Schematic	C39757
C1	Capacitor, .05 µF, 12 V	C0672
C2	Capacitor, .05 µF, 12 V	C0672
R1	Resistor, 4.7 k, 5%, 1/4 W	R0892
U1	Integrated Circuit, SN74145N	25754
U2	Integrated Circuit, SN15846N	19716
U3	Integrated Circuit, MC1806P	25733
U4	Integrated Circuit, SN15862N	19719
U5	Integrated Circuit, MC1808P	25734
U6	Integrated Circuit, SN15846N	19716
U7	Integrated Circuit, SN74145N	25754
U8	Integrated Circuit, MC857P	25753
U9	Integrated Circuit, MC1808P	25734
U10	Resistor Network, 4 x 5 k, 1/10 W	27867
U11	Resistor Network, 4 x 5 k, 1/10 W	27867
U12	Resistor Network, 4 x 5 k, 1/10 W	27867
U13	Resistor Network, 4 x 5 k, 1/10 W	27867
U14	Resistor Network, 4 x 5 k, 1/10 W	27867
U15	Resistor Network, 4 x 5 k, 1/10 W	27867
U16	Resistor Network, 4 x 5 k, 1/10 W	27867
U17	Resistor Network, 4 x 5 k, 1/10 W	27867
	DELETE	
A6	Attenuator Select P.C. Assembly	B39355
A7	Function Select P.C. Assembly	B39803
X15	Cover Plate, 50 pin	39443-2

OPTION 21
REMOTE PROGRAMMING
(All Controls, Single Line, Ground True)

DESCRIPTION

This Option provides remote control of all switchable front panel controls, with the exception of the POWER switch, in a single line format. The remote control circuits use ground "1" to operate the functions. REMOTE connector J14 is a 50 pin Amphenol 57-40500.

REMOTE PIN ASSIGNMENTS

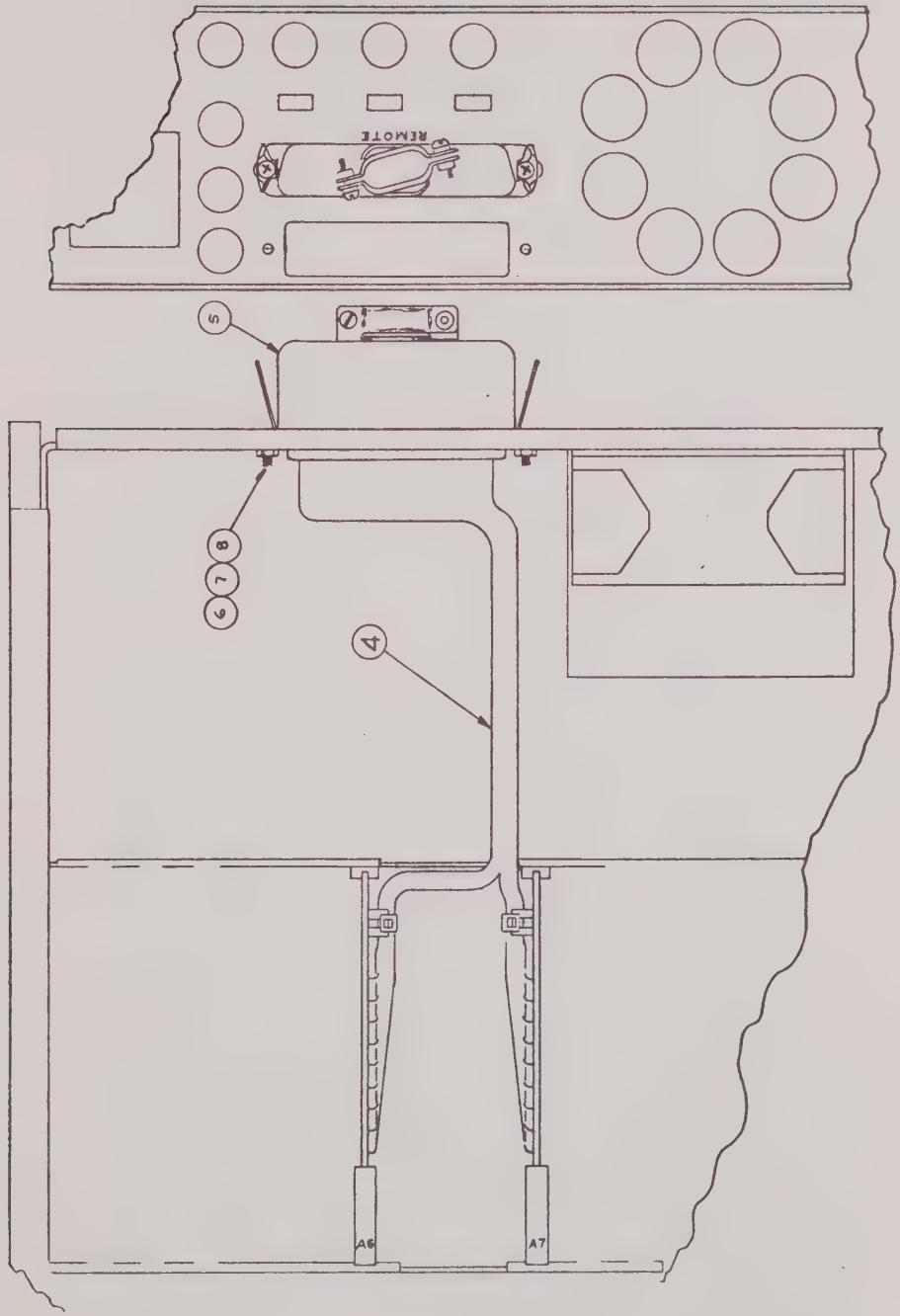
PIN	DESCRIPTION
1	TEST
2	RATIO
3	10 ns
4	100 ns
5	1 µs
6	10 µs
7	100 µs
8	1 ms
9	10 ms
10	100 ms
11	1 SEC
12	.1 Hz
13	FAST RECYCLE RATE
14	TIM
15	RATE D
16	RATE A
17	COUNT A
18	HOLD
19	P/R x 1
20	P/R x 10
21	P/R x 10^2
22	P/R x 10^3
23	P/R x 10^4
24	P/R x 10^5
25	A x 1
26	A x 10
27	A x 100
28	A-DC
29	B x 1
30	B x 10
31	B x 100
32	B-DC
33	B ("-" SLOPE)
34	C x 1
35	C x 10
36	C x 100
37	C-DC

REMOTE PIN ASSIGNMENTS (Cont'd)

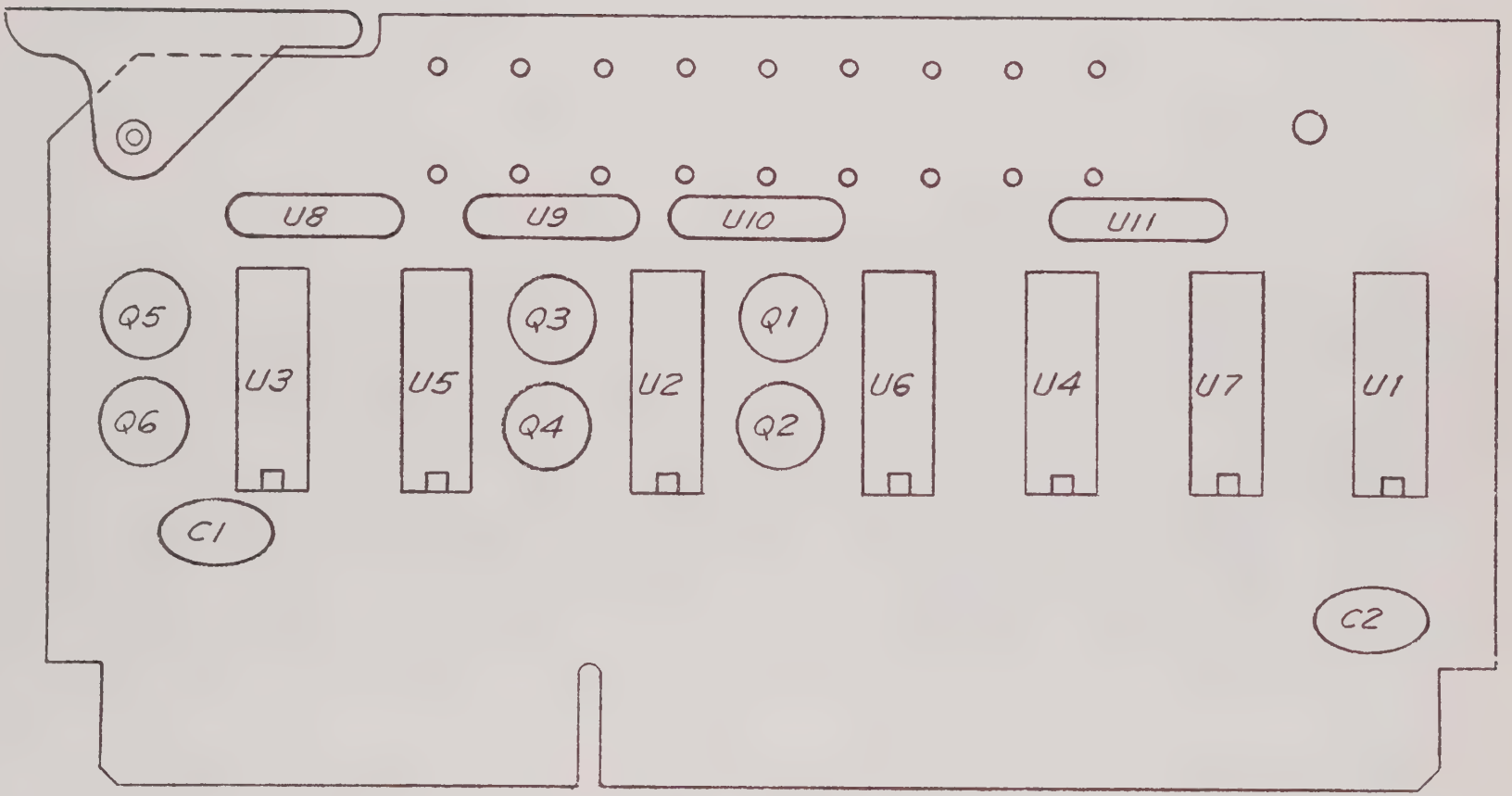
PIN	DESCRIPTION
38	C ("-" SLOPE)
39	B+C COM.
40	RESET
47	REMOTE AMPLIFIERS
48	REMOTE FUNCTION AND TIME BASE
49	GND
50	GND

DRAWINGS

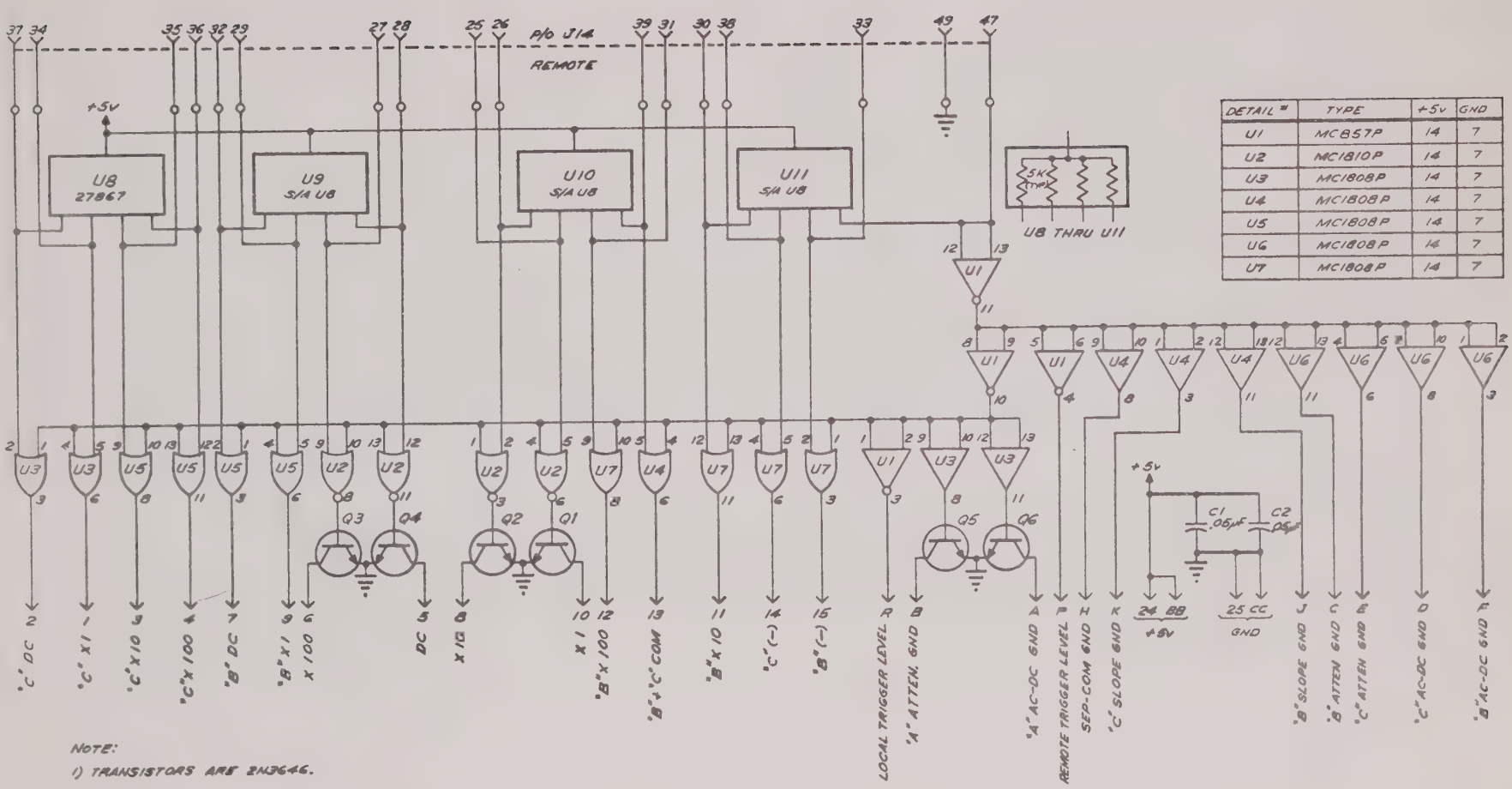
Option 21, Final Assembly #C45084
Option 21, A6, Single Line Attenuator Select P.C. Assembly #B39752
Option 21, A6, Single Line Attenuator Select Schematic #C39749
Option 21, A7, Single Line Function Select P.C. Assembly #B39748
Option 21, A7, Single Line Function Select Schematic #D39745
Option 21, Final Assembly Parts List #P/L45084



OPTION 21, FINAL ASSEMBLY #C45084



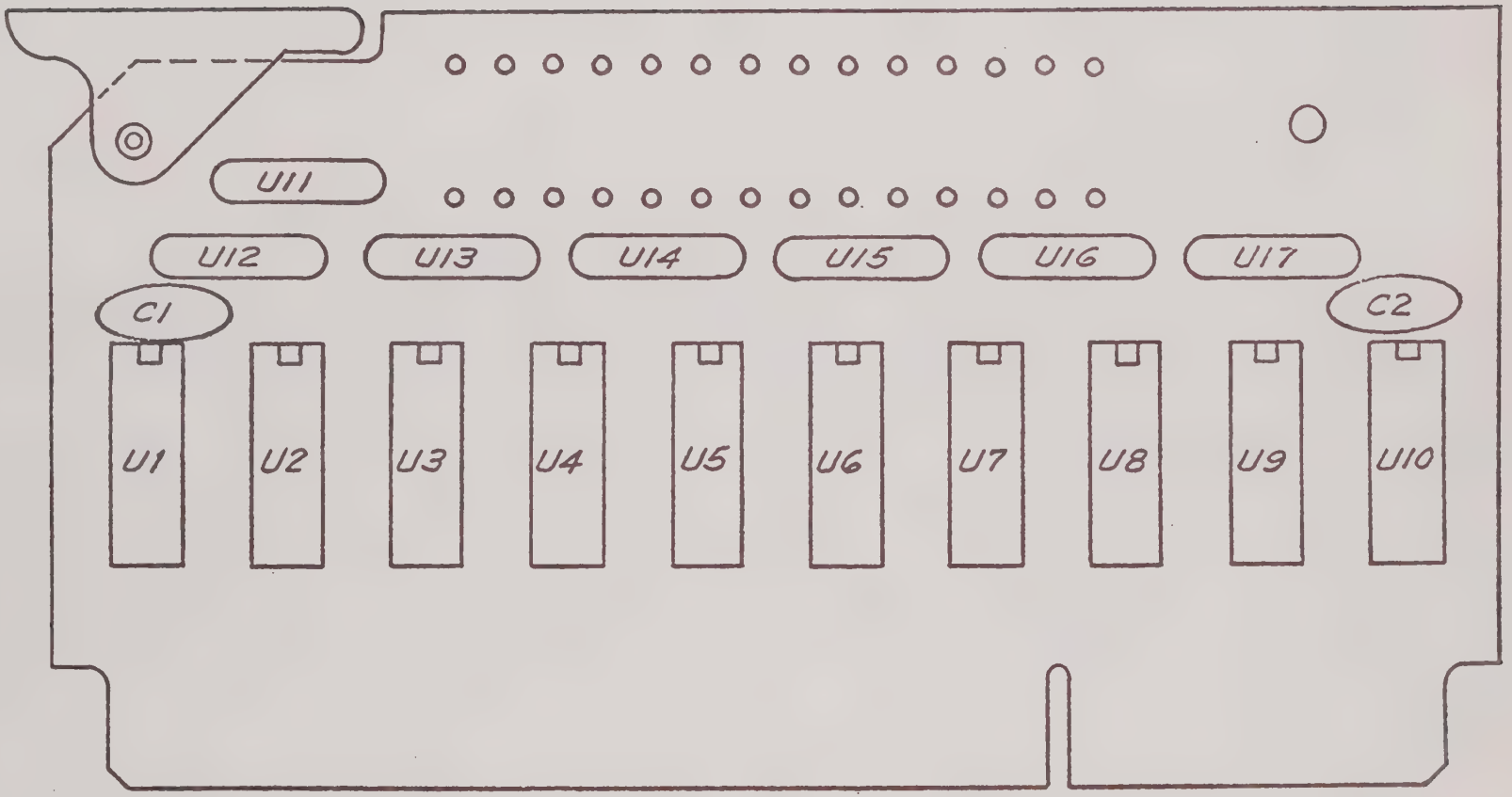
OPTION 21, A6, SINGLE LINE ATTENUATOR SELECT P.C. ASSEMBLY #B39752



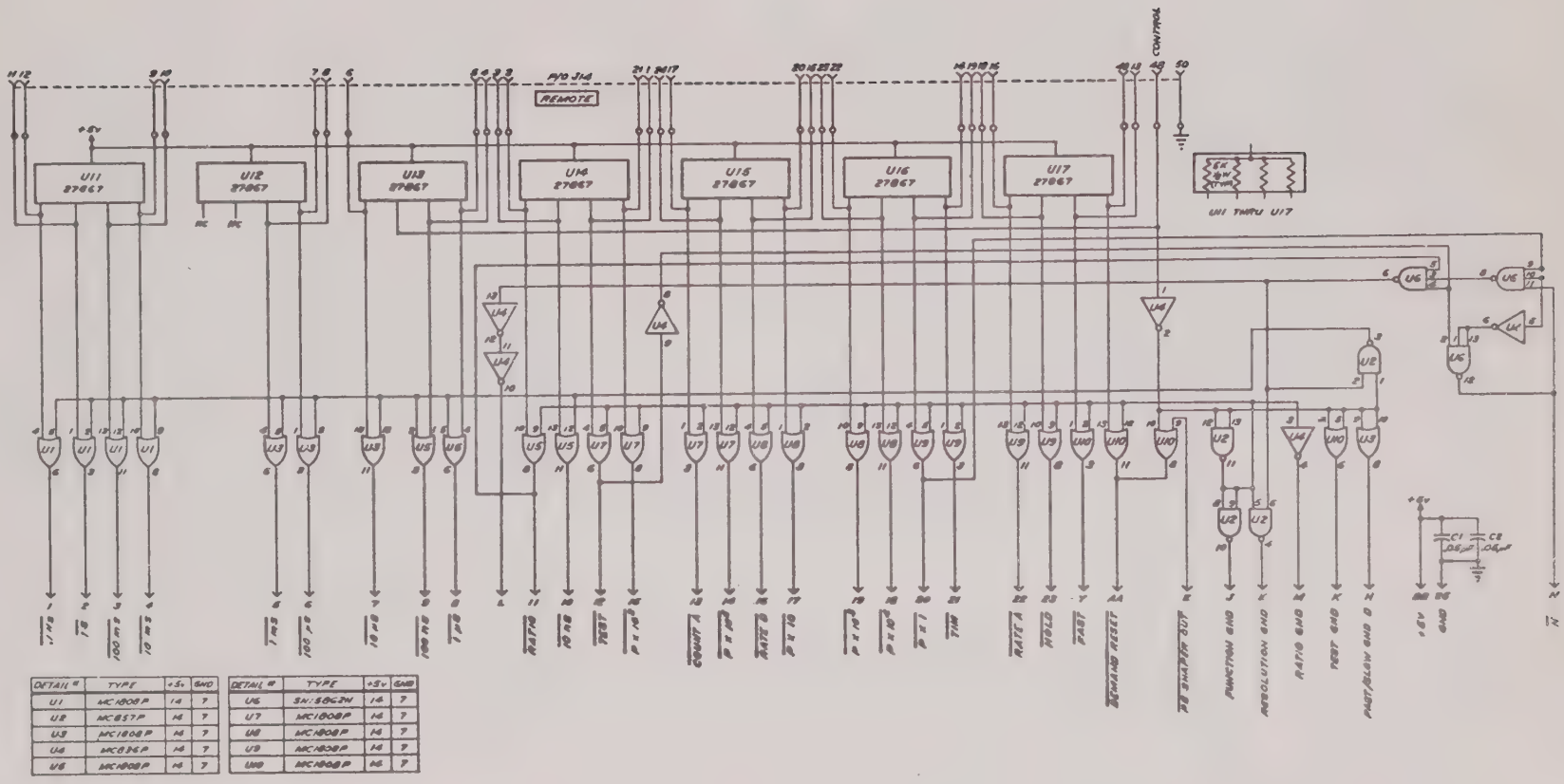
DETAIL #	TYPE	+5V	GND
U1	MC857P	14	7
U2	MC1810P	14	7
U3	MC1808P	14	7
U4	MC1808P	14	7
U5	MC1808P	14	7
U6	MC1808P	14	7
U7	MC1808P	14	7

NOTE:
1) TRANSISTORS ARE 2N3646.

OPTION 21, A6, SINGLE LINE ATTENUATOR SELECT SCHEMATIC #C39749



OPTION 21, A7, SINGLE LINE FUNCTION SELECT P.C. ASSEMBLY #B39748



DETAIL #	TYPE	+5v	GND
U1	MC1808P	14	7
U2	MC857P	14	7
U3	MC1808P	14	7
U4	MC836P	14	7
U5	MC1808P	14	7

DETAIL #	TYPE	+5v	GND
U6	SN/54C2W	14	7
U7	MC1808P	14	7
U8	MC1808P	14	7
U9	MC1808P	14	7
U10	MC1808P	14	7

OPTION 21, A7, SINGLE LINE FUNCTION SELECT SCHEMATIC #D39745

OPTION 21 FINAL ASSEMBLY PARTS LIST

Ref.	Description	SD Part No.
	Option 21 Final Assembly	C45084
	ADD	
4	Single Line Remote Assembly consisting of:	C39808
4	Single Line Attenuator Select P.C. Assembly	B39752
5	Single Line Function Select P.C. Assembly	B39748
6	Single Line Remote Cable Assembly	B39807
P14	Connector, w/hood, 50 pin	J0171
	* * * * * * * * * * * * * * * * * * *	
A6	Single Line Attenuator Select P.C. Assembly	B39752
A6	Single Line Attenuator Select P.C. Schematic	C39749
C1	Capacitor, .05 µF, 12 V	C0672
C2	Capacitor, .05 µF, 12 V	C0672
Q1	Transistor, 2N3646	Q0218
Q2	Transistor, 2N3646	Q0218
Q3	Transistor, 2N3646	Q0218
Q4	Transistor, 2N3646	Q0218
Q5	Transistor, 2N3646	Q0218
Q6	Transistor, 2N3646	Q0218
U1	Integrated Circuit, MC857P	25753
U2	Integrated Circuit, MC1810P	25735
U3	Integrated Circuit, MC1808P	25734
U4	Integrated Circuit, MC1808P	25734
U5	Integrated Circuit, MC1808P	25734
U6	Integrated Circuit, MC1808P	25734
U7	Integrated Circuit, MC1808P	25734
U8	Resistor Network, 4 x 5 k, 1/10 W	27867
U9	Resistor Network, 4 x 5 k, 1/10 W	27867
U10	Resistor Network, 4 x 5 k, 1/10 w	27867
U11	Resistor Network, 4 x 5 k, 1/10 W	27867
	* * * * * * * * * * * * * * * * * * *	
A7	Single Line Function Select P.C. Assembly	B39748
A7	Single Line Function Select P.C. Schematic	D39745
C1	Capacitor, .05 µF, 12 V	C0672
C2	Capacitor, .05 µF, 12 V	C0672

OPTION 21 FINAL ASSEMBLY PARTS LIST (Cont'd)

Ref.	Description	SD Part No.
U1	Integrated Circuit, MC1808P	25734
U2	Integrated Circuit, MC857P	25653
U3	Integrated Circuit, MC1808P	25734
U4	Integrated Circuit, MC836P	25704
U5	Integrated Circuit, MC1808P	25734
U6	Integrated Circuit, SN15862N	19719
U7	Integrated Circuit, MC1808P	25734
U8	Integrated Circuit, MC1808P	25734
U9	Integrated Circuit, MC1808P	25734
U10	Integrated Circuit, MC1808P	25734
U11	Resistor Network, 4 x 5 k, 1/10 W	27867
U12	Resistor Network, 4 x 5 k, 1/10 W	27867
U13	Resistor Network, 4 x 5 k, 1/10 W	27867
U14	Resistor Network, 4 x 5 k, 1/10 W	27867
U15	Resistor Network, 4 x 5 k, 1/10 W	27867
U16	Resistor Network, 4 x 5 k, 1/10 W	27867
U17	Resistor Network, 4 x 5 k, 1/10 W	27867
	* * * * * * * * * * * * * * * * * * *	
	Single Line Remote Cable Assembly	B39807
J14	Connector, 50 pin	J0170
	DELETE	
A6	Attenuator Select P.C. Assembly	B39355
A7	Function Select P.C. Assembly	B39803
X15	Cover Plate, 50 pin	39443-2

OPTION 22
REMOTE PROGRAMMING
(Function and Resolution, Group Binary, Ground True)

DESCRIPTION

This Option provides remote control of the Function and Resolution controls in a group binary format. The remote control circuits use ground "1" to operate the functions. REMOTE connector J14 is a 50 pin Amphenol 57-40500.

REMOTE PIN ASSIGNMENTS

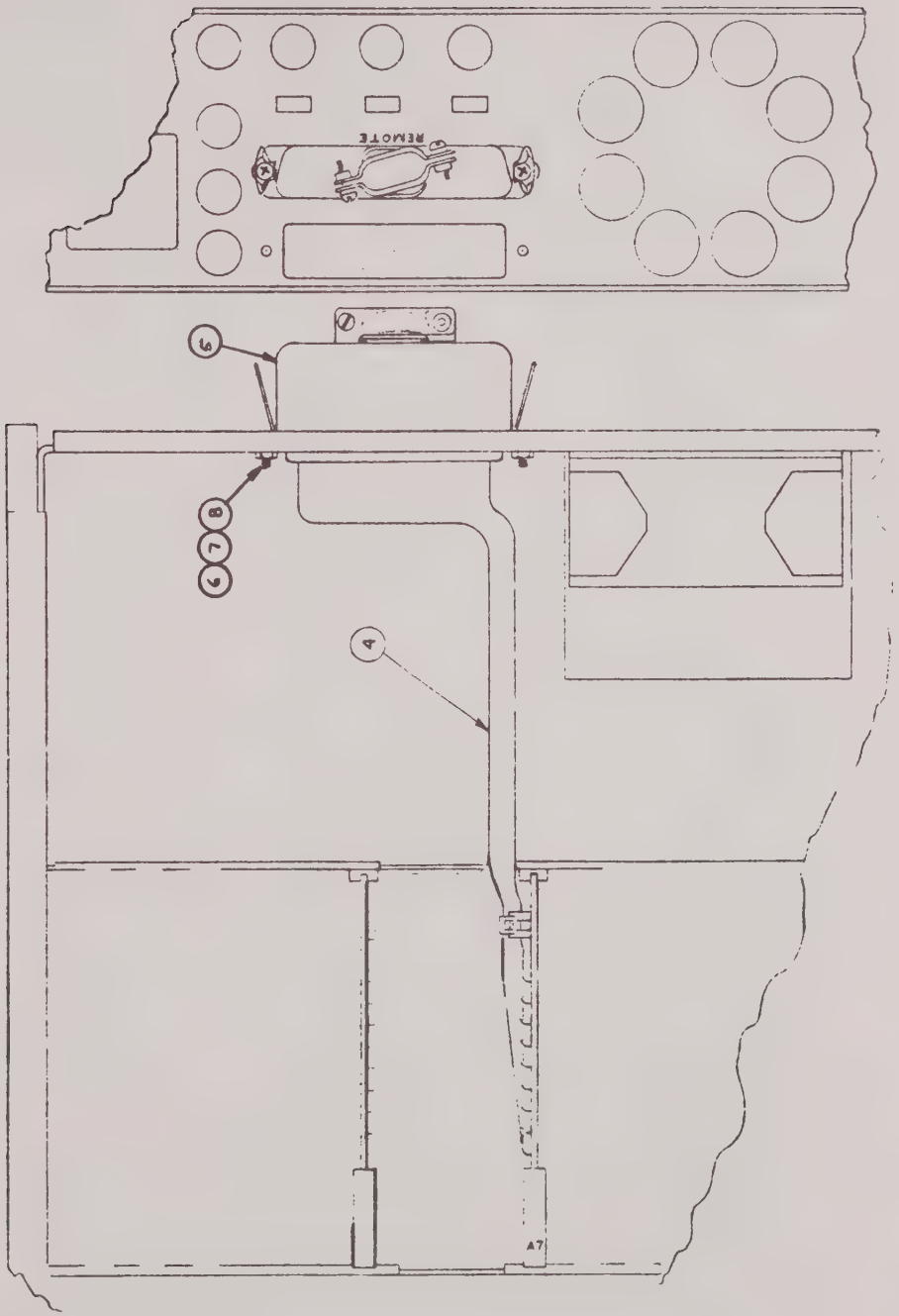
PIN	DESCRIPTION
5	"0" = TEST
4	"0" = FAST/"1" = SLOW
3	"0" = RATIO
2	"0" = RESET
6	RESOLUTION CODE
7	RESOLUTION CODE
8	RESOLUTION CODE
9	RESOLUTION CODE
10	FUNCTION CODE
11	FUNCTION CODE
12	FUNCTION CODE
13	FUNCTION CODE
25	REMOTE/LOCAL
1	GND

RESOLUTION CODE	PIN NO. 6	7	8	9
.1 Hz	1	1	1	1
1 SEC	1	1	1	0
100 ms	1	1	0	1
10 ms	1	1	0	0
1 ms	1	0	1	1
100 µs	1	0	1	0
10 µs	1	0	0	1
1 µs	1	0	0	0
100 ns	0	1	1	1
10 ns	0	1	1	0

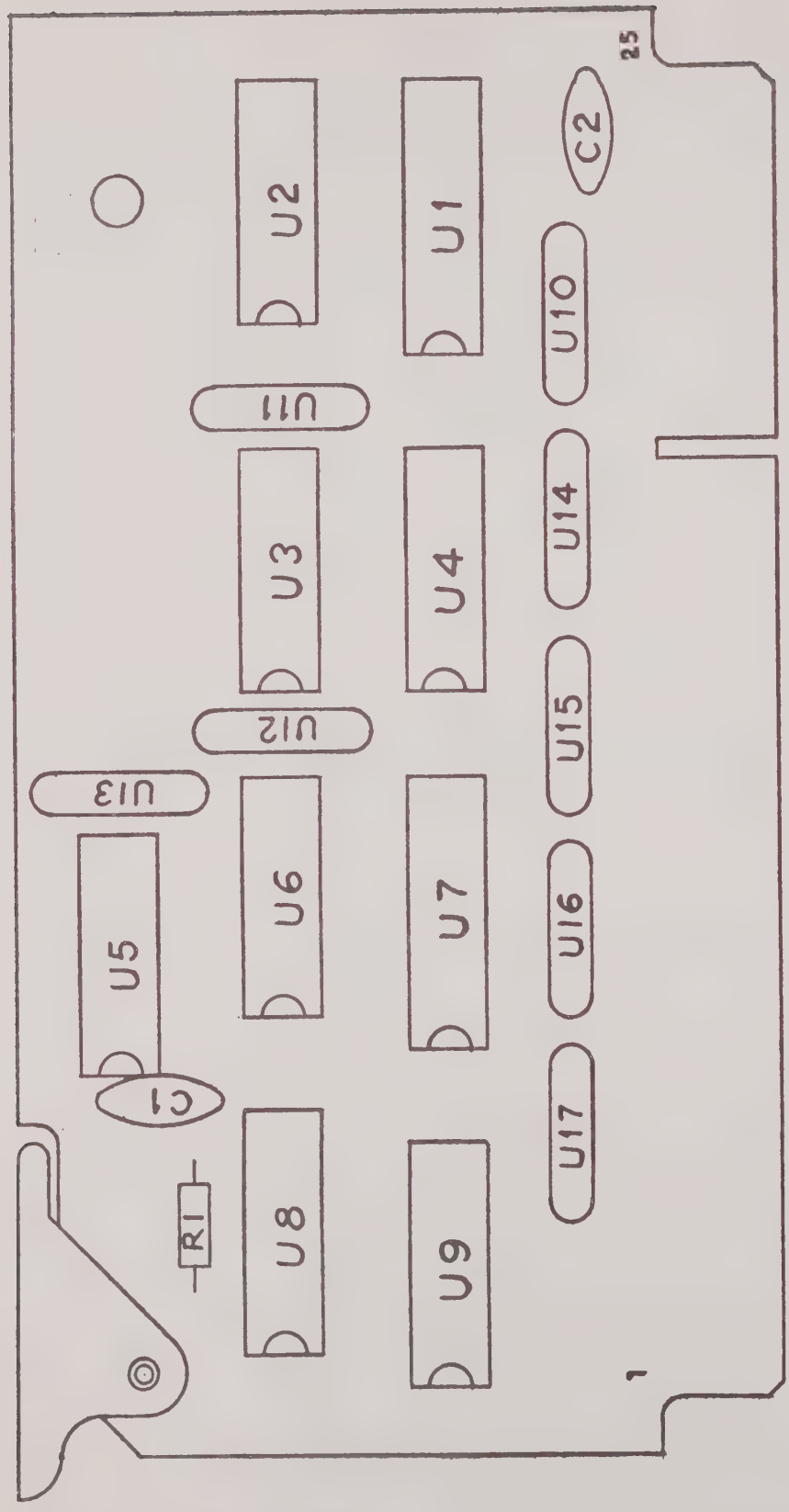
FUNCTION CODE	PIN NO. 10	11	12	13
TIM	1	1	1	1
RATE D	1	1	1	0
RATE A	1	1	0	1
COUNT A	1	1	0	0
HOLD	1	0	1	1
P/R x 1	1	0	1	0
R/R x 10	1	0	0	1
P/R x 10^2	1	0	0	0
P/R x 10^3	0	1	1	1
P/R x 10^4	0	1	1	0
P/R x 10^5	0	1	0	1

DRAWINGS

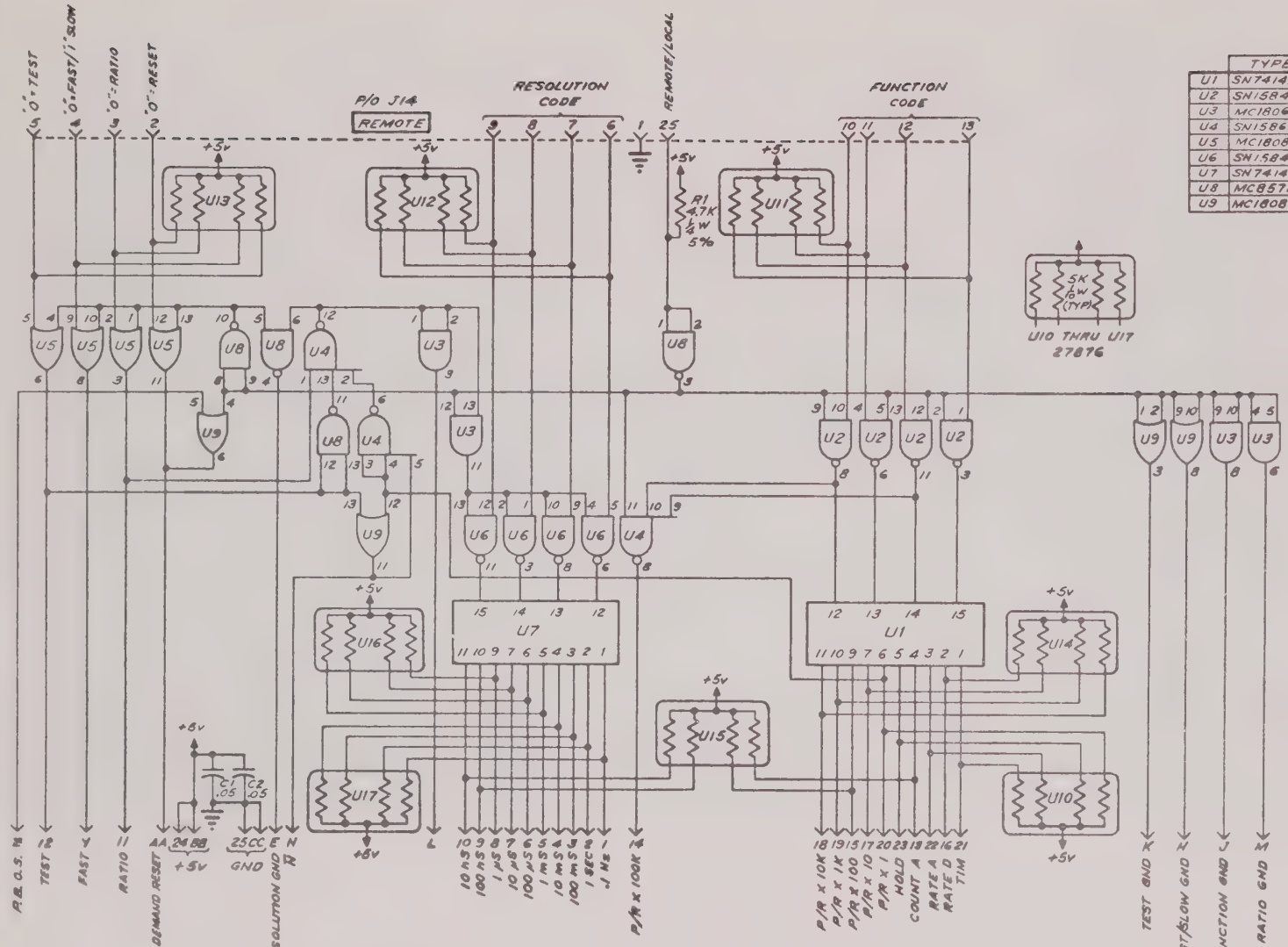
Option 22, Final Assembly #C45363
Option 22, A7, Binary Function Select P.C. Assembly #C39760
Option 22, A7, Binary Function Select Schematic #C39757
Option 22, Final Assembly Parts List #P/L45363



OPTION 22, FINAL ASSEMBLY #C45363



OPTION 22, A7, BINARY FUNCTION SELECT P.C. ASSEMBLY #C39760



	TYPE	+5V	GND
U1	SN74145N	16	8
U2	SN1584GN	14	7
U3	MC1806P	14	7
U4	SN1586ZN	14	7
U5	MC1808P	14	7
U6	SN1584GN	14	7
U7	SN74145N	16	8
U8	MC857P	14	7
U9	MC1808P	14	7

"1" = +5V = LOCAL = SLOW
"0" = 0V = REMOTE = FAST

PIN Nº 10	11	12	13	FUNCTION CODE
1	1	1	1	TIM
1	1	1	0	RATE 0
1	1	0	1	RATE A
1	1	0	0	COUNT A
1	0	1	1	HOLD
1	0	1	0	P/R x 1
1	0	0	1	P/R x 10
1	0	0	0	P/R x 10^2
0	1	1	1	P/R x 10^3
0	1	1	0	P/R x 10^4
0	1	0	1	P/R x 10^5

PIN Nº 6	7	8	9	RESOLUTION CODE
1	1	1	1	.1 Hz
1	1	1	0	1 SEC
1	1	0	1	100 mS
1	1	0	0	10 mS
1	0	1	1	1 mS
1	0	1	0	100 µS
1	0	0	1	10 µS
1	0	0	0	1 µS
0	1	1	1	100 nS
0	1	1	0	10 nS

OPTION 22, A7, BINARY FUNCTION SELECT SCHEMATIC #C39757

OPTION 22 FINAL ASSEMBLY PARTS LIST

Ref.	Description	SD Part No.
	Option 22 Final Assembly	C45363
	ADD	
4	Binary Remote Function Assembly	C45362
	Consisting of:	
A7	Binary Function Select P.C. Assembly	C39760
A7	Binary Remote Function Cable Assembly	B45361
J14	Connector, 50 Pin	J0170
P14	Connector, w/hood, 50 pin	J0171
	* * * * * * * * * * * * * * * * * * *	
	Binary Function Select P.C. Assembly	C39760
	Binary Function Select P.C. Schematic	C39757
C1	Capacitor, .05 µF, 12 V	C0672
C2	Capacitor, .05 µF, 12 V	C0672
R1	Resistor, 4.7 k, 5%, 1/4 W	R0892
U1	Integrated Circuit, SN74145N	25754
U2	Integrated Circuit, SN15846N	19716
U3	Integrated Circuit, MC1806P	25733
U4	Integrated Circuit, SN15862N	19719
U5	Integrated Circuit, MC1808P	25734
U6	Integrated Circuit, SN15846N	19716
U7	Integrated Circuit, SN74145N	25754
U8	Integrated Circuit, MC857P	25753
U9	Integrated Circuit, MC1808P	25734
U10	Resistor Network, 4 x 5 k, 1/10 W	27867
U11	Resistor Network, 4 x 5 k, 1/10 W	27867
U12	Resistor Network, 4 x 5 k, 1/10 W	27867
U13	Resistor Network, 4 x 5 k, 1/10 W	27867
U14	Resistor Network, 4 x 5 k, 1/10 W	27867
U15	Resistor Network, 4 x 5 k, 1/10 W	27867
U16	Resistor Network, 4 x 5 k, 1/10 W	27867
U17	Resistor Network, 4 x 5 k, 1/10 W	27867
	* * * * * * * * * * * * * * * * * * *	
	DELETE	
A7	Function Select P.C. Assembly	B39803

OPTION 23
REMOTE PROGRAMMING
(Function and Resolution, Single Line, Ground True)

DESCRIPTION

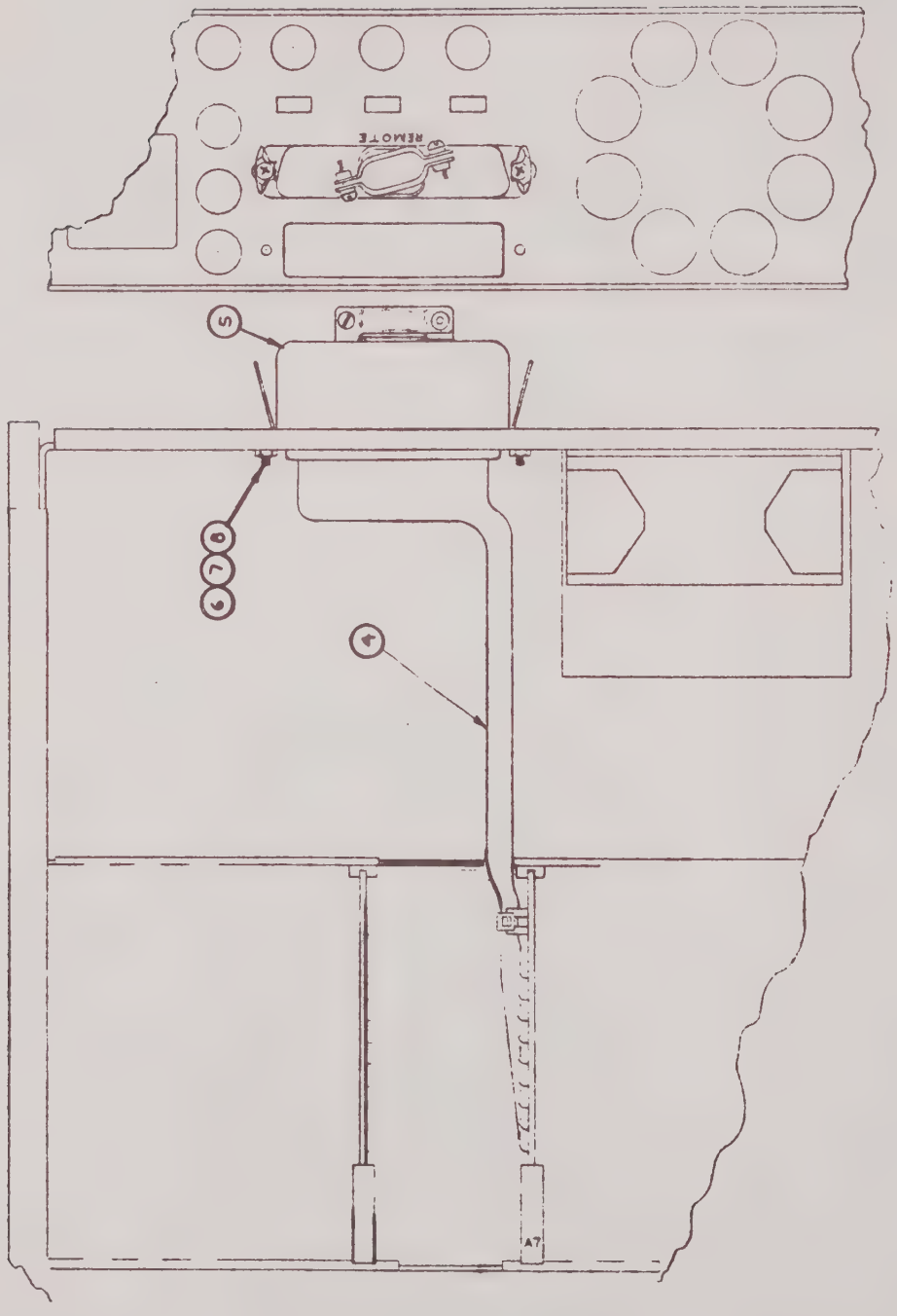
This Option provides remote control of the Function and Resolution front panel controls in a single line format. The remote control circuits use ground "1" to operate the functions. REMOTE connector J14 is a 50 pin Amphenol 57-40500.

REMOTE PIN ASSIGNMENTS

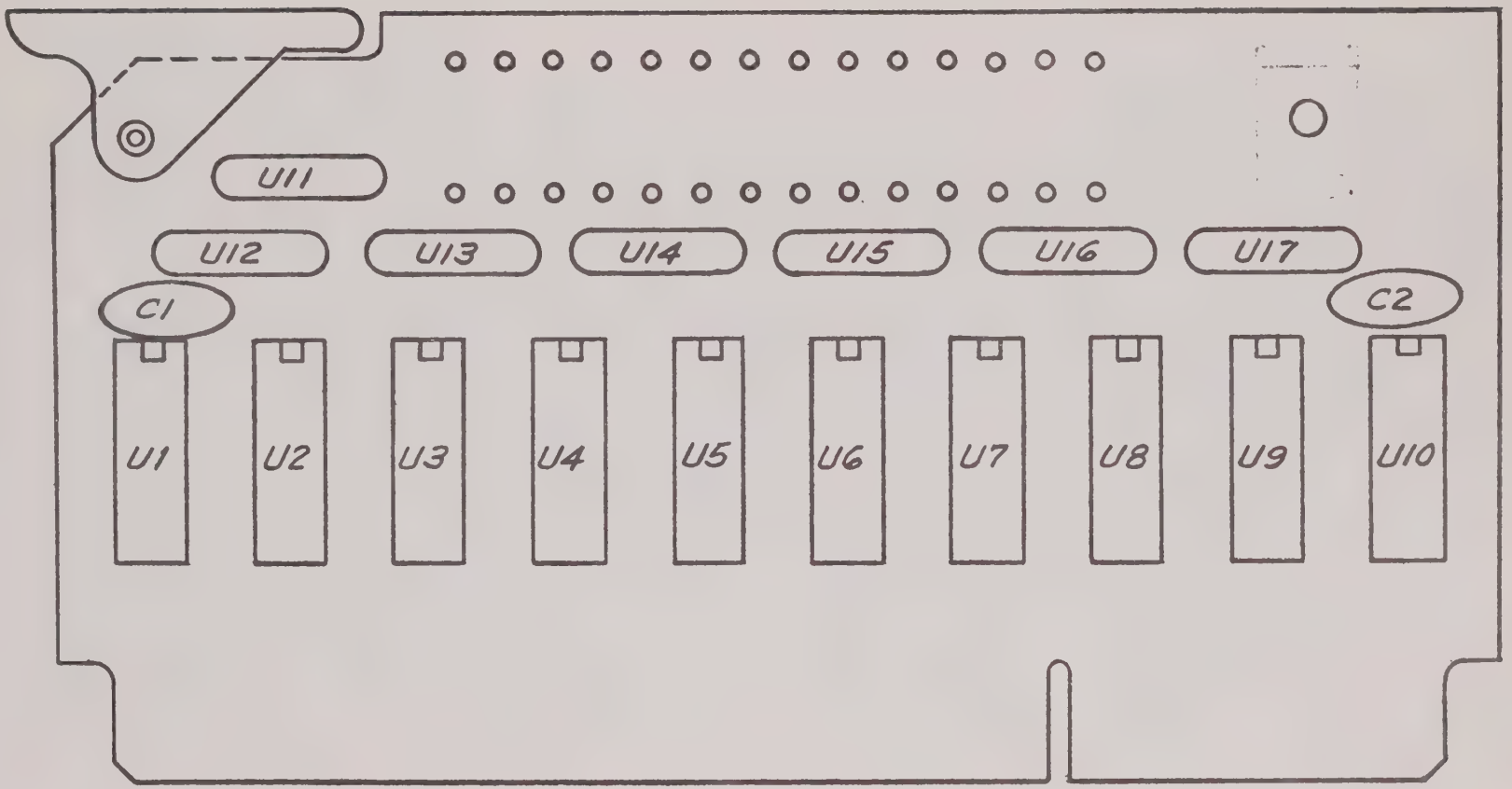
PIN	DESCRIPTION
1	TEST
2	RATIO
3	10 ns
4	100 ns
5	1 µs
6	10 µs
7	100 µs
8	1 ms
9	10 ms
10	100 ms
11	1 SEC
12	.1 Hz
13	FAST RECYCLE RATE
14	TIM
15	RATE D
16	RATE A
17	COUNT A
18	HOLD
19	P/R x 1
20	P/R x 10
21	P/R x 10^2
22	P/R x 10^3
23	P/R x 10^4
24	P/R x 10^5
40	RESET
48	REMOTE FUNCTION & TIME BASE
50	BND

DRAWINGS

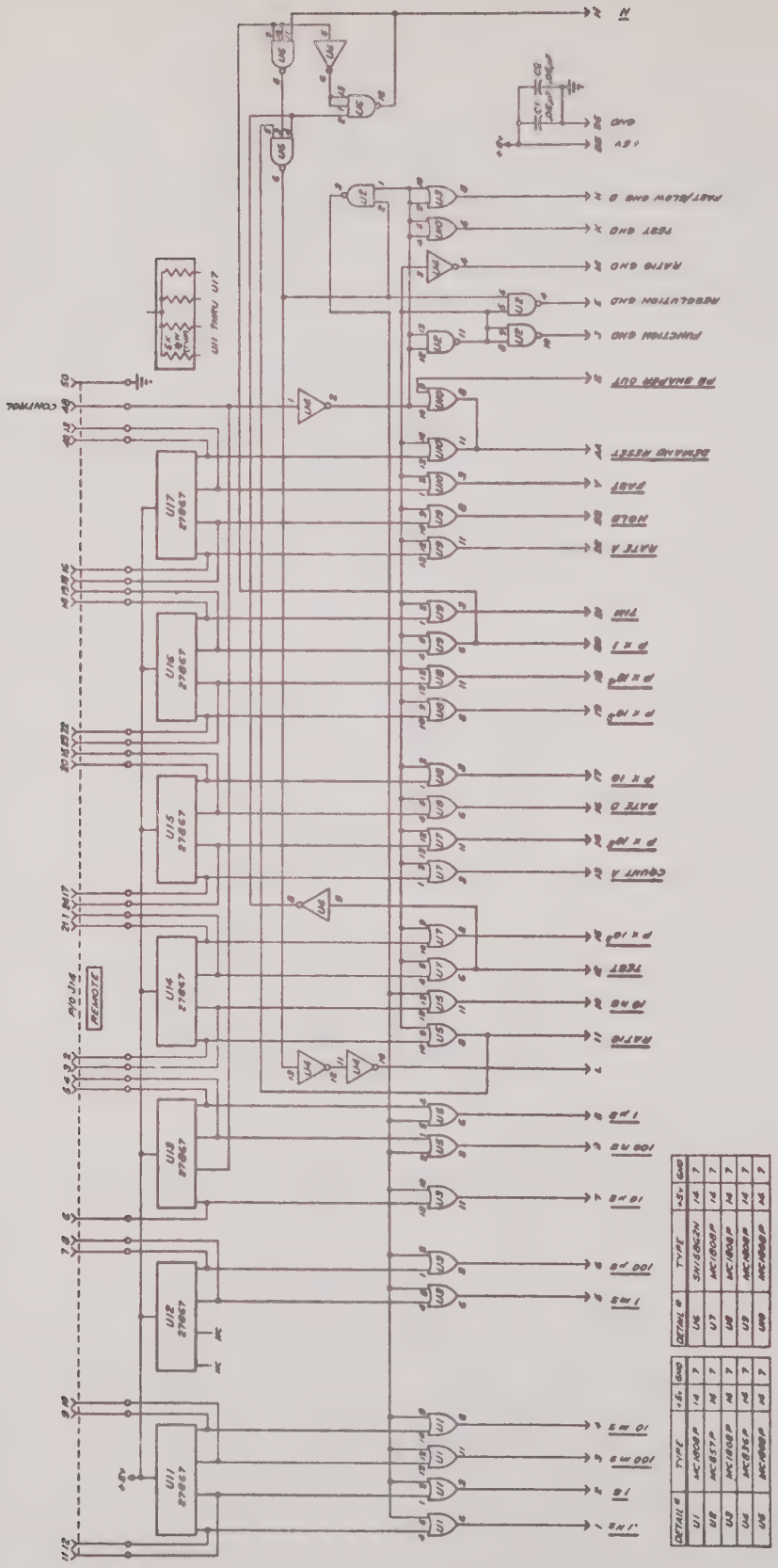
Option 23, Final Assembly #C45368
Option 23, A7, Single Line Function Select P.C. Assembly #B39748
Option 23, A7, Single Line Function Select Schematic #D39745
Option 23, Final Assembly Parts List #P/L45368



OPTION 23, FINAL ASSEMBLY #C45368



OPTION 23, A7, SINGLE LINE FUNCTION SELECT P.C. ASSEMBLY #B39748



OPTION 23, A7, SINGLE LINE FUNCTION SELECT SCHEMATIC #D39745

OPTION 23 FINAL ASSEMBLY PARTS LIST

Ref.	Description	SD Part No.
	Option 23 Final Assembly	C45368
	ADD	
4	Single Line Remote Function Assembly	C45367
	Consisting of:	
4	Single Line Function Select P.C. Assembly	B39748
5	Single Line Remote Function Cable Assembly	B45366
P14	Connector, w/hood, 50 pin	J0171
	* * * * * * * * * * * * * * * * * * *	
A7	Single Line Function Select P.C. Assembly	B39748
A7	Single Line Function Select P.C. Schematic	D39745
C1	Capacitor, .05 µF, 12 V	C0672
C2	Capacitor, .05 µF, 12 V	C0672
U1	Integrated Circuit, MC1808P	25734
U2	Integrated Circuit, MC857P	25753
U3	Integrated Circuit, MC1808P	25734
U4	Integrated Circuit, MC836P	25704
U5	Integrated Circuit, MC1808P	25734
U6	Integrated Circuit, SN15862N	19719
U7	Integrated Circuit, MC1808P	25734
U8	Integrated Circuit, MC1808P	25734
U9	Integrated Circuit, MC1808P	25734
U10	Integrated Circuit, MC1808P	25734
U11	Resistor Network, 4 x 5 k, 1/10 W	27867
U12	Resistor Network, 4 x 5 k, 1/10 W	27867
U13	Resistor Network, 4 x 5 k, 1/10 W	27867
U14	Resistor Network, 4 x 5 k, 1/10 W	27867
U15	Resistor Network, 4 x 5 k, 1/10 W	27867
U16	Resistor Network, 4 x 5 k, 1/10 W	27867
U17	Resistor Network, 4 x 5 k, 1/10 W	27867
	* * * * * * * * * * * * * * * * * * *	
	Single Line Remote Function Cable Assembly	B45366
J14	Connector, 50 pin	J0170
	DELETE	
A7	Function Select P.C. Assembly	B39803
X14	Cover Plate, 50 pin connector	39443-2

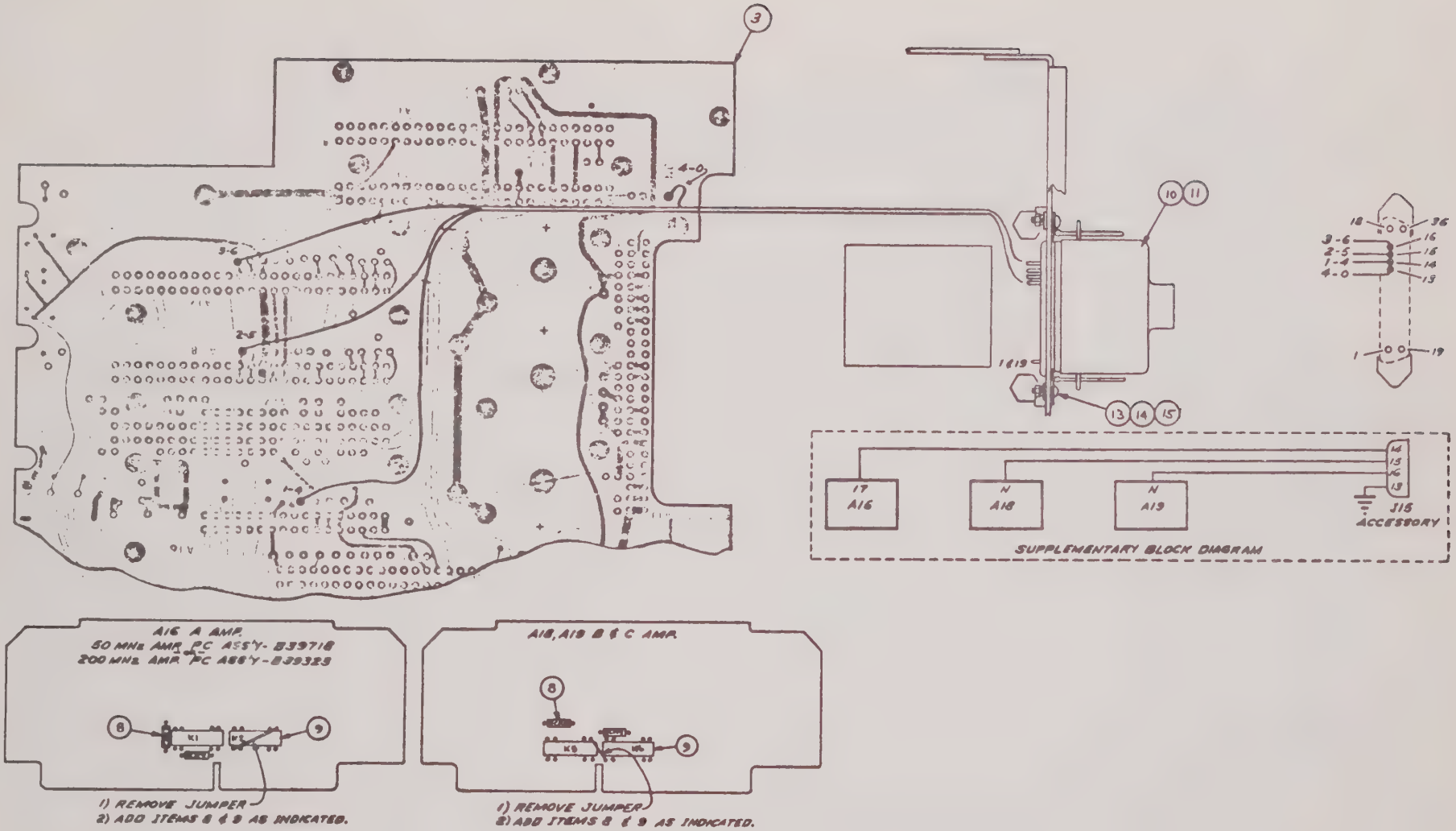
OPTION 26
ANALOG TRIGGER LEVEL CONTROL
(used with Option 20 or 21)

This option provides remote control of the A, B, and C INPUT trigger LEVEL controls by means of analog levels applied to the J15 ACCESSORY connector. This option is used in conjunction with Remote Control Options 20 or 21. The analog levels for each input and the pin assignments are listed below: J15 = AMPEHNOL 57-40360

PIN	FUNCTION
14	±1 V for A INPUT trigger LEVEL
15	±3 V for B INPUT trigger LEVEL
16	±3 V for C INPUT trigger LEVEL
13	GND

The drawings for this option are the following:

Option 26, Final Assembly #C45318
Option 26, Final Assembly Parts List #P/L45318



OPTION 26, FINAL ASSEMBLY C45318

OPTION 26 FINAL ASSEMBLY PARTS LIST

Ref.	Description	SD Part No.
	Option 26 Final Assembly	C45318
3	See Mother P.C. Assembly	C39114
	ADD	
8	Diode, 1N4151	C40150
9	Relay	K0133
J15	Connector, w/bales 36 pin	J0292
P15	Connector, w/hood, 36 pin	J0172

OPTION 27
DIGITAL TRIGGER LEVEL CONTROL
(used with Option 20)

DESCRIPTION

This option allows rear panel digital operation of the A, B,and C INPUT Trigger Level controls. Option 20 REMOTE PROGRAMMING is included in this option and an A17 printed circuit board is added with twelve ATTENUATOR control lines accessable on rear panel connector J15, Amphenol type 36 pin 57-40360.

TRIGGER LEVEL CONTROL PIN ASSIGNMENTS

PIN	FUNCTION	FUNCTION
1	1	
2	2	Remote Binary A AMP ATTENUATOR
3	4	
4	8	
9	1	
10	2	Remote Binary B AMP ATTENUATOR
11	4	
12	8	
5	1	
6	2	Remote Binary C AMP ATTENUTOR
7	4	
8	8	
13	GND	

LEVEL CODING FOR PINS

NOMINAL TRIGGER LEVEL X ATTEN FACTOR

STATE	CODE				TRIGGER LEVEL	
	1	2	4	8	A	B&C
0	+	+	+	+	+0.9996	+2.996
1	0	+	+	+	+0.8568	+2.568
2	+	0	+	+	+0.7140	+2.140
3	0	0	+	+	+0.5712	+1.712
4	+	+	0	+	+0.4284	+1.284
5	0	+	0	+	+0.2856	+0.856
6	+	0	0	+	+0.1428	+0.428

7	0	0	0	+	0.0000	0.000
8	+	+	+	0	-0.1428	-0.428
9	0	+	+	0	-0.2856	-0.856
10	+	0	+	0	-0.4284	-1.284
11	0	0	+	0	-0.5712	-1.172
12	+	+	0	0	-0.7140	-2.140
13	0	+	0	0	-0.8568	-2.568
14	+	0	0	0	-0.9996	-2.996
15	0	0	0	0	-1.1424	-3.424

+ = +2.5V tp +5.0V, OR OPEN CIRCUIT

0 = 0.0V to +0.5V, OR SWITCH TO GND OR SATURATED NPN

DRAWINGS

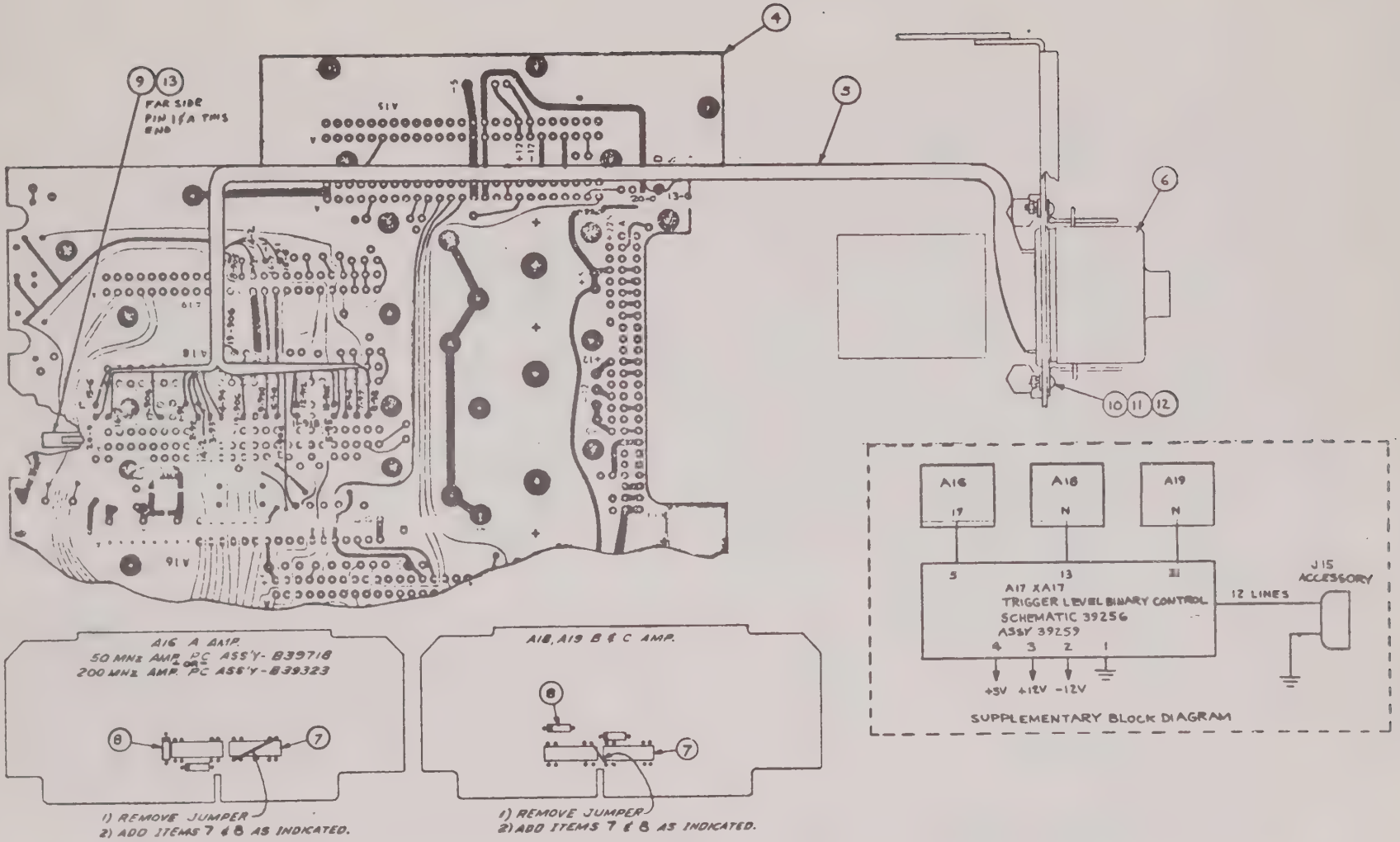
Option 27, Final Assembly #C45387
Option 27, Cable Assembly #B45386
Option 27, Final Assembly Parts List #P/L45387
Option 27, Trigger Level Binary Control P.C. Assembly #B39259
Option 27, Trigger Level Binary Control Schematic #D39256
Option 27, Trigger Level Binary Control Parts List #P/L39259

CALIBRATION PROCEDURE - A AMP

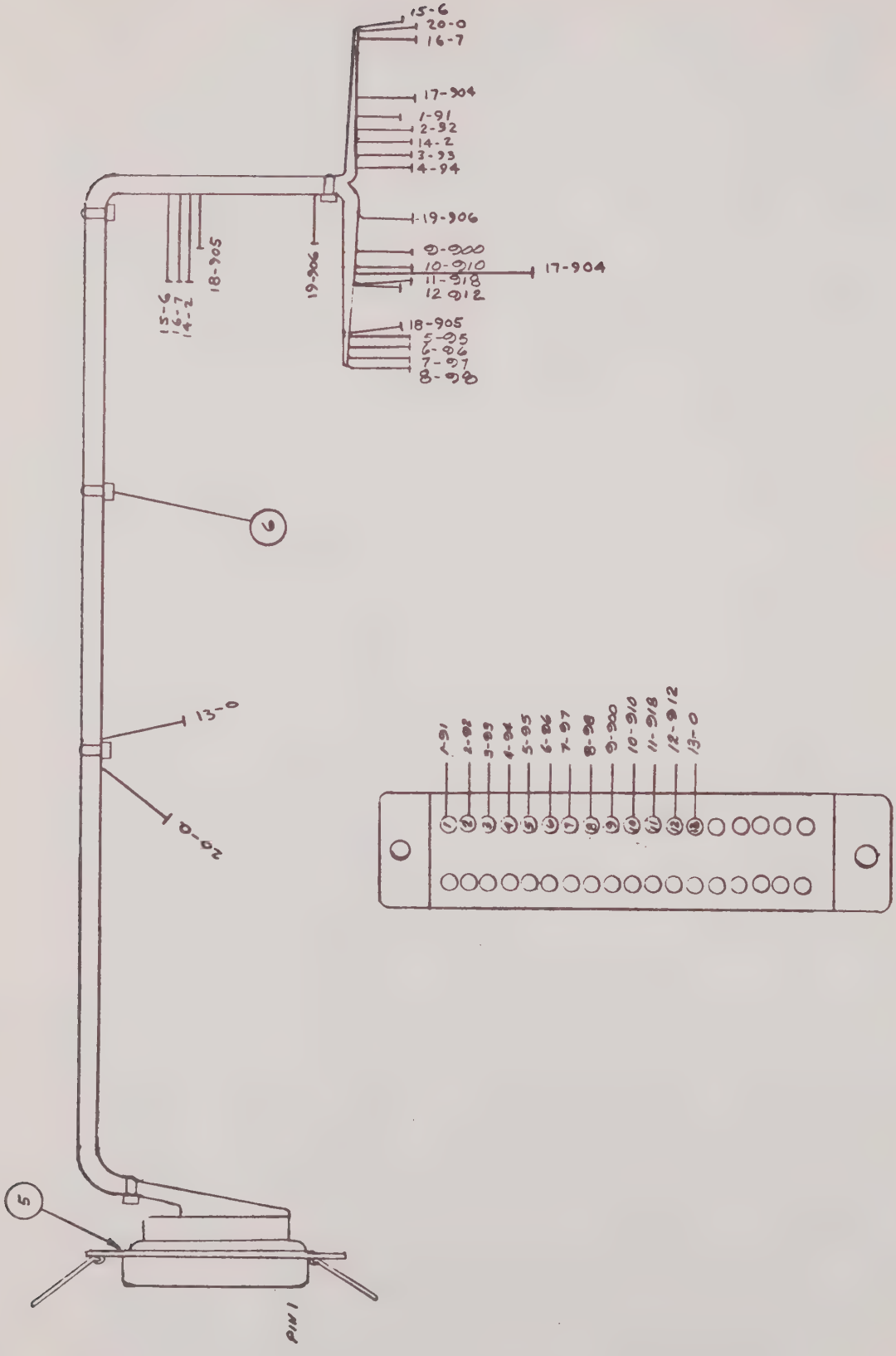
1) Set BCD to STATE 7 (low on pins 1,2,3 and high on pin 4 of J15).
2) Measure voltage at pin E on P.C. connector XA17 with DVM.
3) Adjust A AMP ZERO, A17R5, for 0.0000 V dc.
4) Set BCD to STATE 0 (high on pins 1,2,3, and 4 of J15).
5) Adjust A AMP F.S., A17R8, for +0.9996 V dc.
6) Repeat steps 1) through 5).
7) Accuracy should be better than 3%.

CALIBRATION PROCEDURE - B OR C AMP

1) Set BCD to STATE 7 (low on pins 9,10, & 11 and high on pin 12 for B AMP or low on pins 5,6, & 7 and high on pin 8 for C AMP).
2) Measure voltage at pin P (B AMP) or Y (C AMP) on P.C. connector XA17 with DVM.
3) Adjust B AMP ZERO, A17R14, or C AMP ZERO, A17R23 for 0.0000 V dc.
4) Set BCD to STATE 0 (high on pins 9,10,11, and 12 for B AMP and high on pins 5,6,7, and 8 for C AMP on J15).
5) Adjust B AMP F.S., A17R17, or C AMP F.S., A17R26, for +2.996 V dc.
6) Repeat steps 1) through 5).
7) Accuracy should be better than 3%.



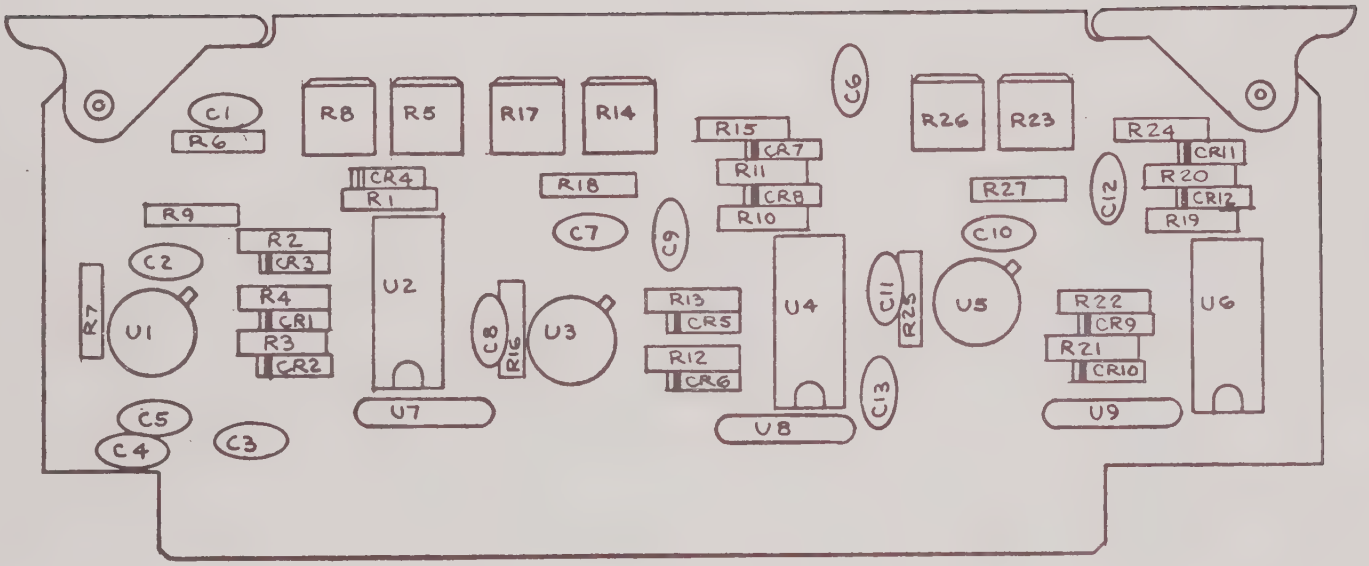
OPTION 27, FINAL ASSEMBLY #C45387



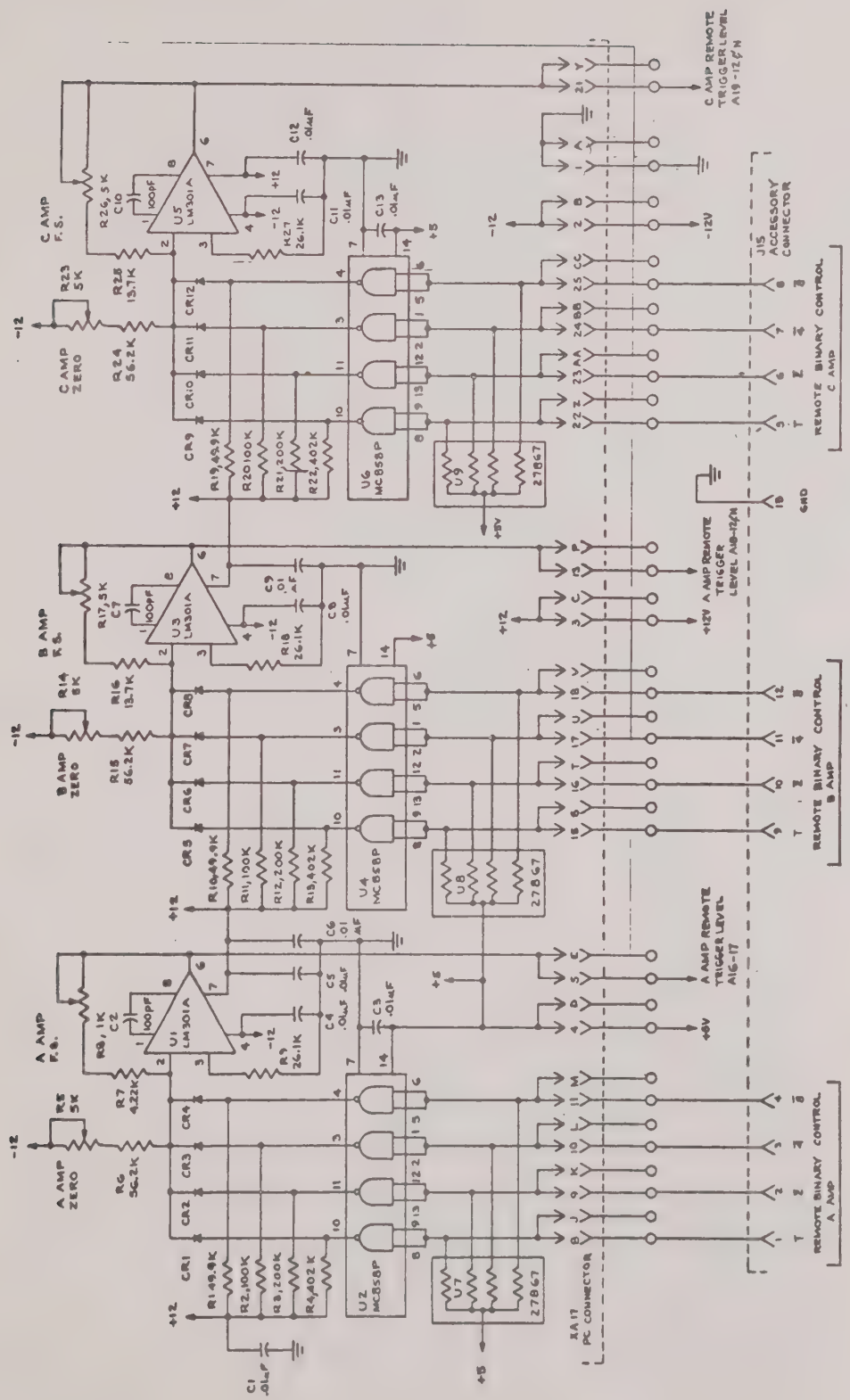
OPTION 27, CABLE ASSEMBLY #B45386

OPTION 27 FINAL ASSEMBLY PARTS LIST

Ref.	Description	SD Part No.
	Option 27 Final Assembly	C45387
	ADD	
4	See Option 20 Final Assembly	C45356
5	Option 27 Cable Assembly	B45386
A17	See Trigger Level Binary Control P.C. Assembly	B39259
P15	Connector, 2/hood, 36 pin	J0172
7	Relay	K0133
8	Diode, 1N4151	CR0150
XA14	Connector, 50 pin, P.C.	
	* * * * * * * * * * * * * * * * * * * *	
	Option 27 Cable Assembly	45386
J15	Connector, 36 pin	J0292
	DELETE	
19	Cover Plate, 36 pin	39621



OPTION 27, TRIGGER LEVEL BINARY CONTROL P.C. ASSEMBLY #B39259



OPTION 27, TRIGGER LEVEL BINARY CONTROL SCHEMATIC #D39256

A17 TRIGGER LEVEL BINARY CONTROL P.C. ASSEMBLY PARTS LIST

Ref.	Description	SD Part No.
A17	Trigger Level Binary Control P.C. Assembly	B39259
	Trigger Level Binary Control P.C. Schematic	D39256
C1	Capacitor, .01 µF, 150 V, disc	C0233
C2	Capacitor, 100 pF, DM15	C0536
C3	Capacitor, .01 µF, 150 V, disc	C0233
C4	Capacitor, .01 µF, 150 V, disc	C0233
C5	Capacitor, .01 µF, 150 V, disc	C0233
C6	Capacitor, .01 µF, 150 V, disc	C0233
C7	Capacitor, 100 pF, DM15	C0536
C8	Capacitor, .01 µF, 150 V, disc	C0233
C9	Capacitor, .01 µF, 150 V, disc	C0233
C10	Capacitor, 100 pF, DM15	C0536
C11	Capacitor, .01 µF, 150 V, disc	C0233
C12	Capacitor, .01 µF, 150 V, disc	C0233
C13	Capacitor, .01 µF, 150 V, disc	C0233
CR1	Diode, 1N4151	CR0150
CR2	Diode, 1N4151	CR0150
CR3	Diode, 1N4151	CR0150
CR4	Diode, 1N4151	CR0150
CR5	Diode, 1N4151	CR0150
CR6	Diode, 1N4151	CR0150
CR7	Diode, 1N4151	CR0150
CR8	Diode, 1N4151	CR0150
CR9	Diode, 1N4151	CR0150
CR10	Diode, 1N4151	CR0150
CR11	Diode, 1N4151	CR0150
CR12	Diode, 1N4151	CR0150
R1	Resistor, 49.9 k, 1%, 1/8 W, MF	R2642
R2	Resistor, 100 k, 1%, 1/8 W, MF	R2638
R3	Resistor, 200 k, 1%, 1/8 W, MF	R2643
R4	Resistor, 402 k, 1%, 1/8 W, MF	R2798
R5	Resistor, 5 k, potentiometer	R2801
R6	Resistor, 56.2 k, 1%, 1/8 W, MF	R2799
R7	Resistor, 4.22 k, 1%, 1/8 W, MF	R2800
R8	Resistor, 1 k, potentiometer	R2734
R9	Resistor, 26.7 k, 1%, 1/8 W, MF	R2762
R10	Resistor, 49.9 k, 1%, 1/8 W, MF	R2642
R11	Resistor, 100 k, 1%, 1/8 W, MF	R2638
R12	Resistor, 200 k, 1%, 1/8 W, MF	R2643

A17 TRIGGER LEVEL BINARY CONTROL P.C. ASSEMBLY PARTS LIST (Cont'd)

Ref.	Description	SD Part No.
R13	Resistor, 402 k, 1%, 1/8 W, MF	R2798
R14	Resistor, 5 k, potentiometer	R2801
R15	Resistor, 56.2 k, 1%, 1/8 W, MF	R2799
R16	Resistor, 13.7 k, 1%, 1/8 W, MF	R2802
R17	Resistor, 5 k, potentiometer	R2801
R18	Resistor, 26.7 k, 1%, 1/8 W, MF	R2762
R19	Resistor, 49.9 k, 1%, 1/8 W, MF	R2642
R20	Resistor, 100 k, 1%, 1/8 W, MF	R2638
R21	Resistor, 200 k, 1%, 1/8 W, MF	R2643
R22	Resistor, 402 k, 1%, 1/8 W, MF	R2798
R23	Resistor, 5 k, potentiometer	R2801
R24	Resistor, 56.2 k, 1%, 1/8 W, MF	R2799
R25	Resistor, 13.7 k, 1%, 1/8 W, MF	R2802
R26	Resistor, 5 k, potentiometer	R2801
R27	Resistor, 26.7 k, 1%, 1/8 W, MF	R2762
U1	Integrated Circuit, LM301A	25745
U2	Integrated Circuit, MC858P	25748
U3	Integrated Circuit, LM301A	25745
U4	Integrated Circuit, MC858P	25748
U5	Integrated Circuit, LM301A	25745
U6	Integrated Circuit, MC858P	25748
U7	Resistor Network, 5 k	27867
U8	Resistor Network, 5 k	27867
U9	Resistor Network, 5 k	27867

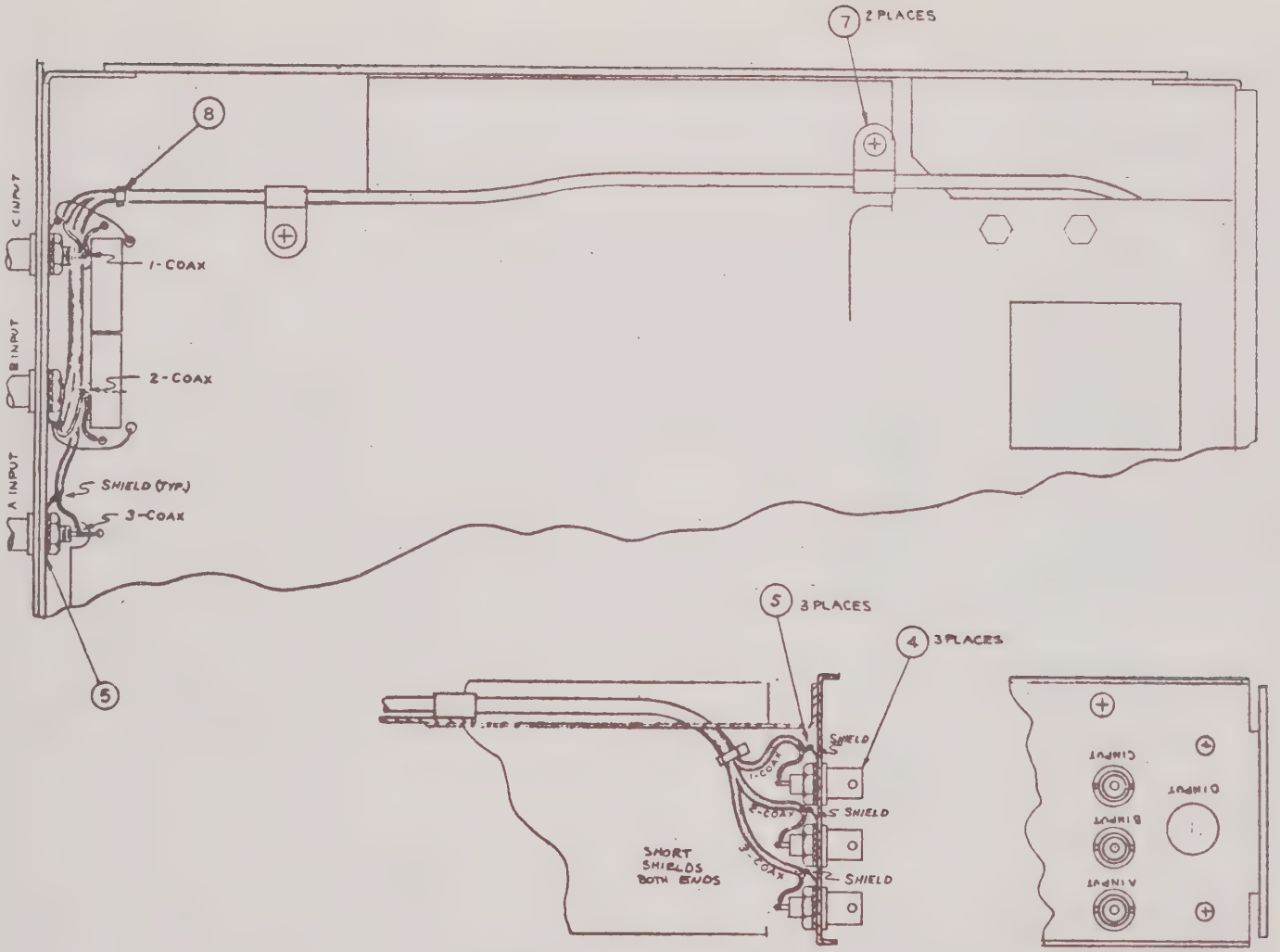
OPTION 32
REAR SIGNAL INPUTS

DESCRIPTION

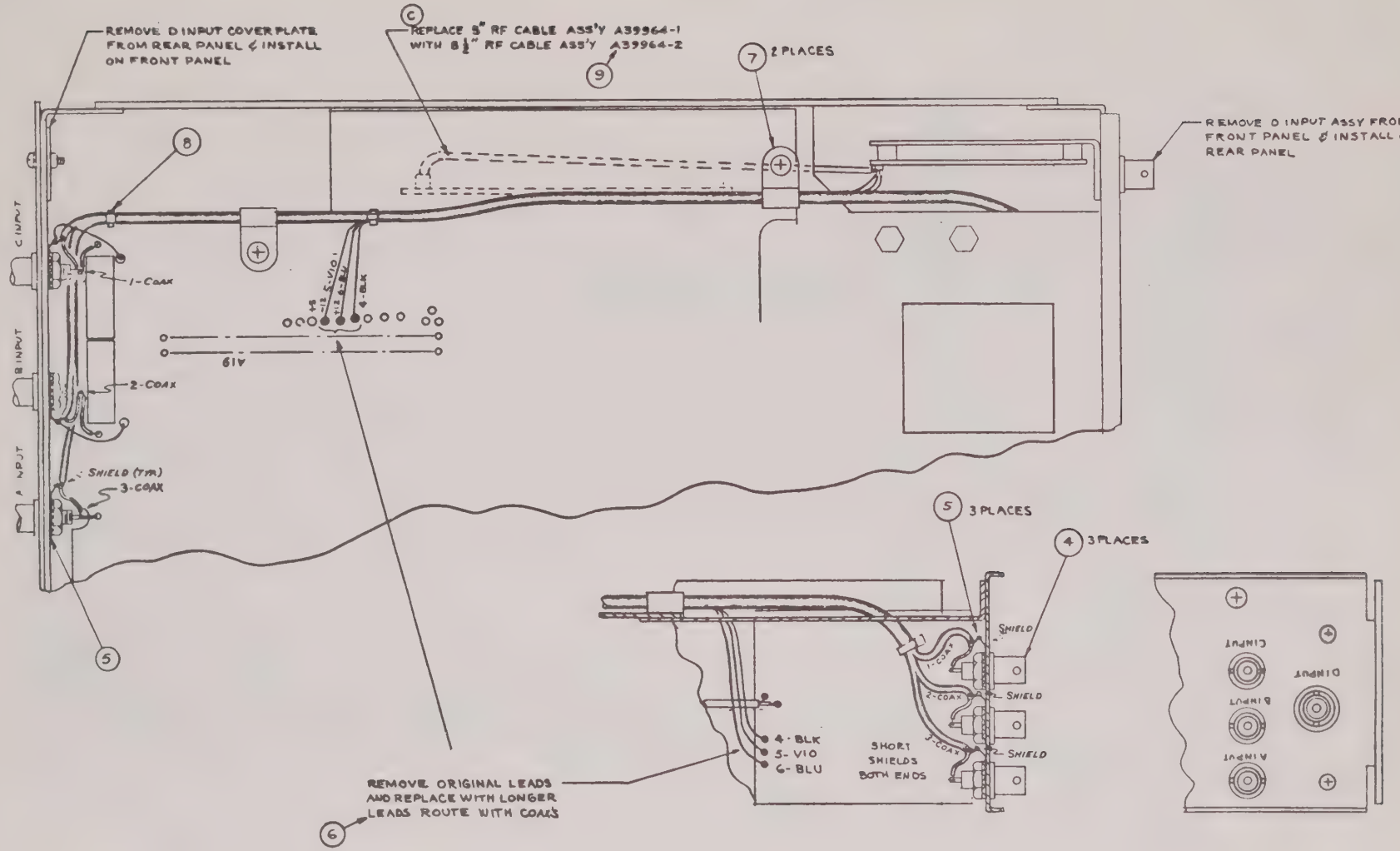
This option places the standard front panel only A, B, C, and D inputs on the rear panel of the instrument. The added A, B, and C rear panel connectors are parallel wired to the corresponding front panel A, B, and C signal inputs. In addition, Models 6152 and 6153 also switch the D INPUT assembly to the rear panel and place the rear panel D INPUT cover plate on the front panel.

DRAWINGS:

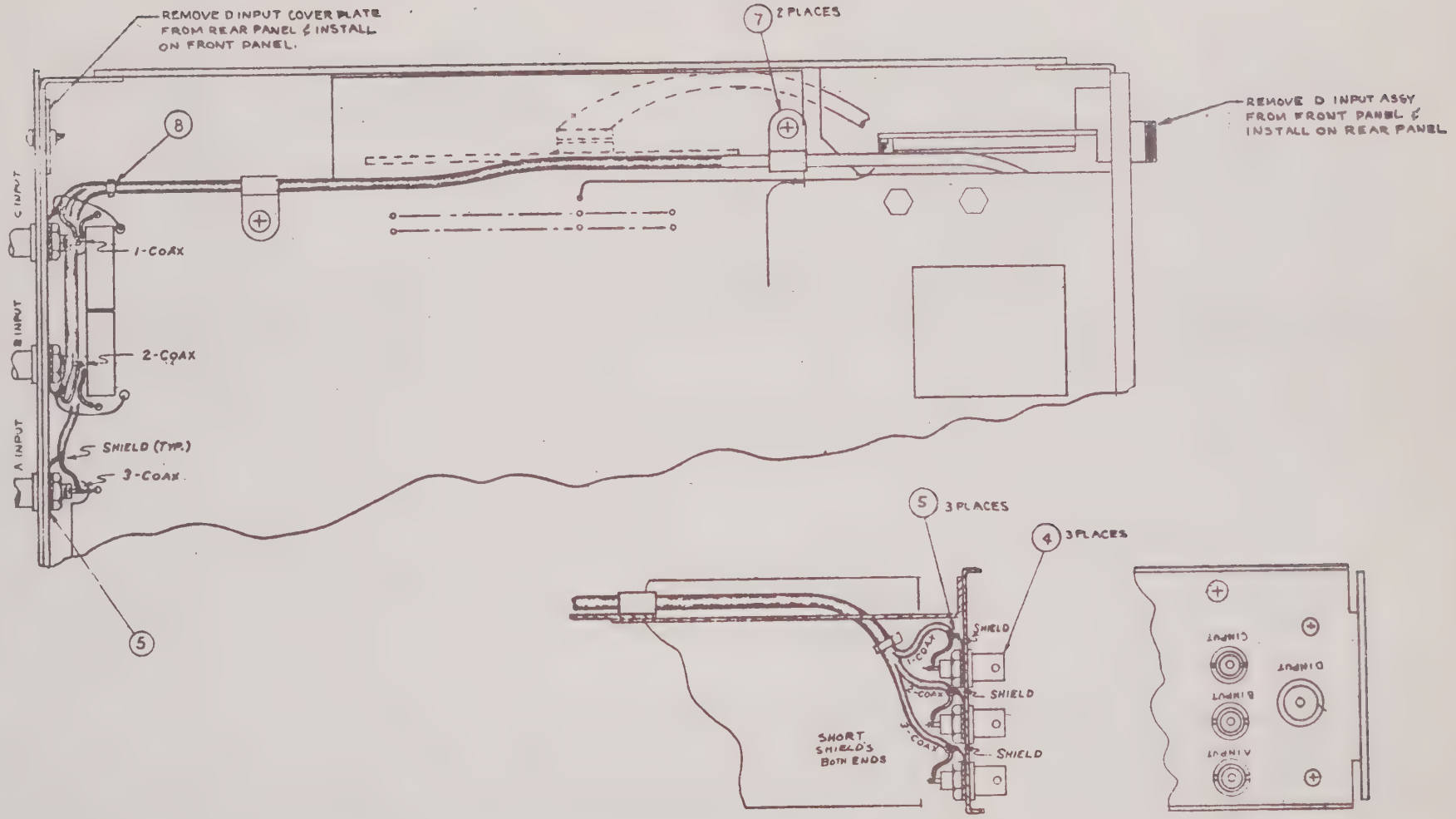
Option 32, Final Assembly Models 6150 and 6151 #C45395
Option 32, Final Assembly Model 6152 #C45396
Option 32, Final Assembly Model 6153 #C45397



OPTION 32, FINAL ASSEMBLY MODELS 6150 and 6151 #C45395



OPTION 32, FINAL ASSEMBLY MODEL 6152 #C45396



OPTION 32, FINAL ASSEMBLY MODEL 6153 #C45397

OPTION 32 FINAL ASSEMBLY PARTS LIST

Ref.	Description	SD Part No.
1	Option 32 Final Assembly Models 6150 & 6151	C45395
1	Option 32 Final Assembly Model 6152	C45396
1	Option 32 Final Assembly Model 6153	C45397
	ADD	
4	Connector, BNC	J0165
	DELETE	
13	Snap Button	H1667

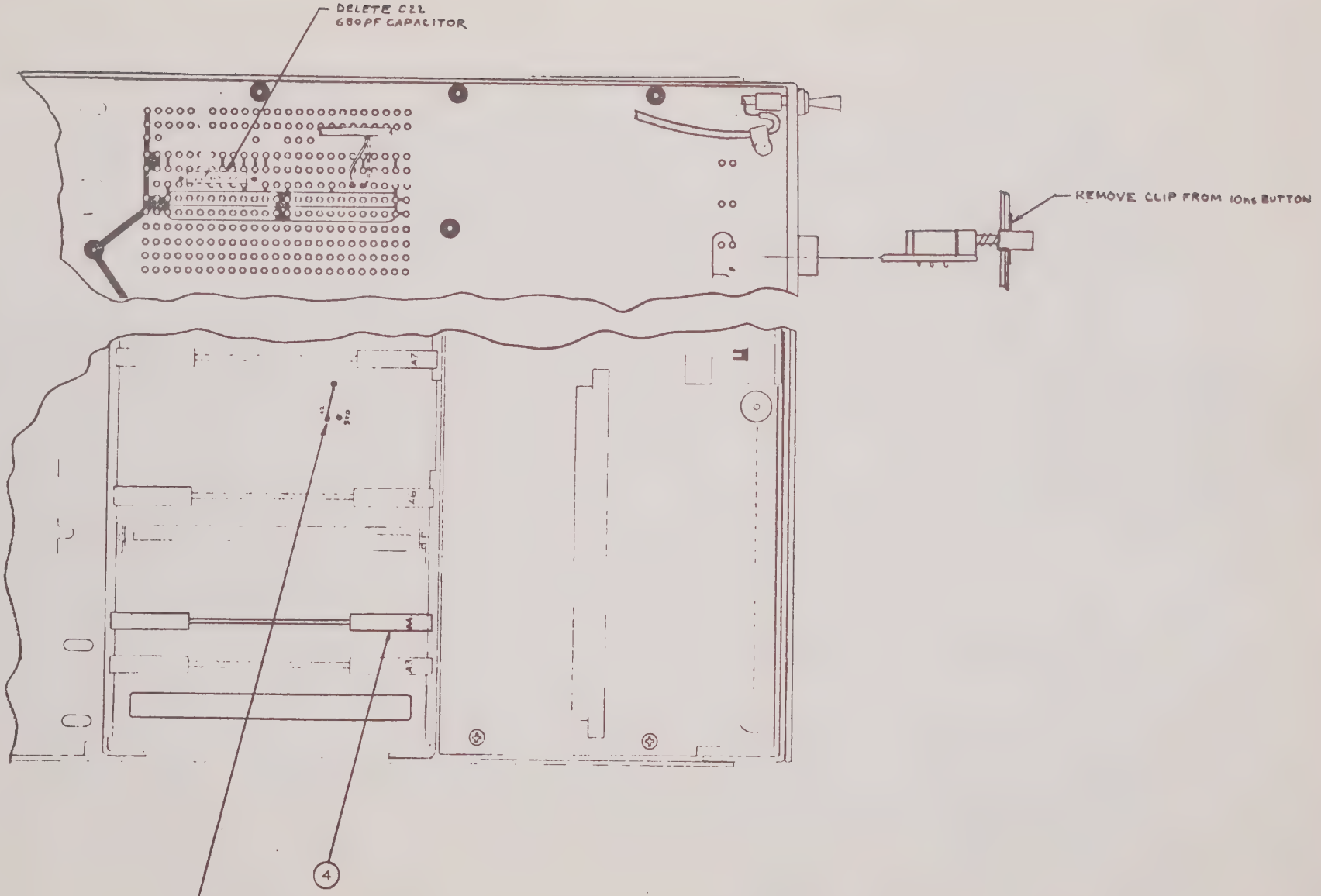
OPTION 42
10 ns TIM AND PERIOD RESOLUTION

DESCRIPTION

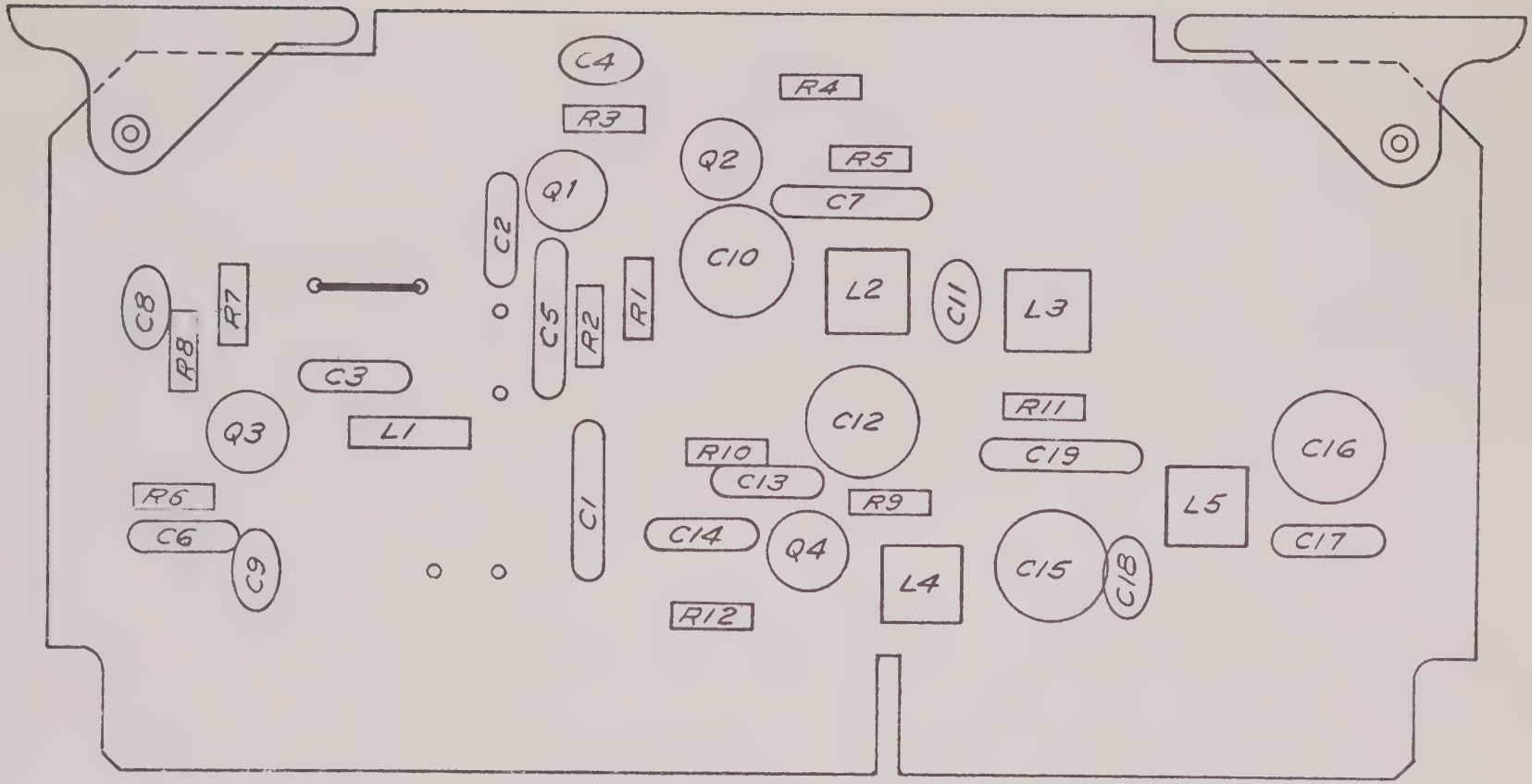
This option provides 10 ns TIM and 10 ns PERIOD resolutions with the following modifications to the standard Model 6150 series units. On the Mother Board the jumper wire to the STD pin is removed and attached with a Teflon sleeve to the 42 pin. Also, remove capacitor C22 from the Mother Board and the clip from the 10 ns front panel pushbutton. A4, 100 MHz MULTIPLIER assembly is inserted into the XA4 connector providing the necessary increased time base frequency.

DRAWINGS

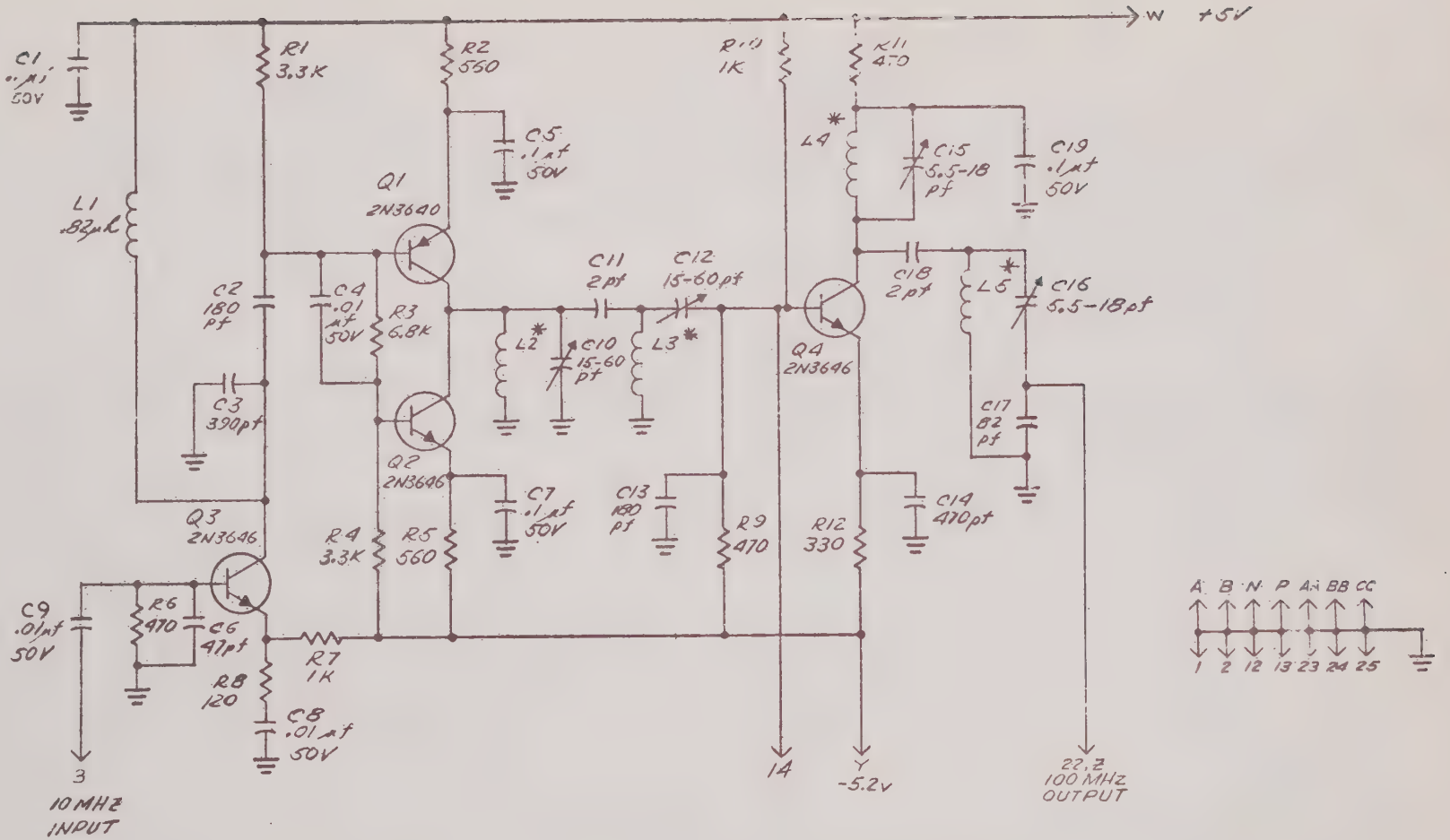
Option 42, Final Assembly #C45401
Option 42, A4, 100 MHz Multiplier P.C. Assembly #B39363
Option 42, A4, 100 MHz Multiplier Schematic #C39360
Option 42, Final Assembly #P/L45401



OPTION 42, FINAL ASSEMBLY #C45401



OPTION 42, A4, 100 MHz MULTIPLIER P.C. ASSEMBLY #B39363



NOTE: UNLESS OTHERWISE NOTED
1.) RESISTORS — 1/4 W., 5%
2.) * INDUCTORS ARE CUSTOM — L2, L3, L4, L5

OPTION 42, A4, 100 MHz MULTIPLIER SCHEMATIC #C39[illegible]50

100 MHz MULTIPLIER P.C. ASSEMBLY

REF.	DESCRIPTION	SD PART NO.
	100 MHz Multiplier P.C. Assembly	B39363
	100 MHz Multiplier P.C. Assembly Schematic	C39360
C1	Capacitor, .1 µF, 50 V	C0881
C2	Capacitor, 180 pF, 500 V	C0707
C3	Capacitor, 390 pF, 500 V	C0541
C4	Capacitor, .01 µF, 50 V	C0562
C5	Capacitor, .1 µF, 50 V	C0881
C6	Capacitor, 47 pF, 500 V	C0533
C7	Capacitor, .1 µF, 50 V	C0881
C8	Capacitor, .01 µF, 50 V	C0562
C9	Capacitor, .01 µF, 50 V	C0562
C10	Capacitor, 15-60 pF	C1132
C11	Capacitor, 2 pF, 500 V	C0261
C12	Capacitor, 15-60 pF	C1132
C13	Capacitor, 180 pF, 500 V	C0707
C14	Capacitor, 470 pF, 300 V	C0542
C15	Capacitor, 5.5-18 pF	C0712
C16	Capacitor, 5.5-18 pF	C0712
C17	Capacitor, 82 pF, 500 V	C0535
C18	Capacitor, 2 pF, 500 V	C0261
C19	Capacitor, .1 µF, 50 V	C0881
L1	Inductor, .82 µh	L0059
L2	Inductor, .82 µh	B39744-1
L3	Inductor, .82 µh	B39744-1
L4	Inductor, .82 µh	B39744-2
L5	Inductor, .82 µh	B39744-2
Q1	Transistor, 2N3640	Q0178
Q2	Transistor, 2N3646	Q0218
Q3	Transistor, 2N3646	Q0218
Q4	Transistor, 2N3646	Q0218
R1	Resistor, 3.3 K, 1/4 W, 5%	R0742
R2	Resistor, 560 Ω, 1/4 W, 5%	R0819
R3	Resistor, 6.8 K, 1/4 W, 5%	R0696
R4	Resistor, 3.3 K, 1/4 W, 5%	R0742
R5	Resistor, 560 Ω, 1/4 W, 5%	R0819

100 MHz MULTIPLIER P.C. ASSEMBLY (CON'D)

REF.	DESCRIPTION	SD PART NO.
R6	Resistor, 470 Ω, 1/4 W, 5%	R1044
R7	Resistor, 1 K, 1/4 W, 5%	R0765
R8	Resistor, 120 Ω, 1/4 W, 5%	R1461
R9	Resistor, 470 Ω, 1/4 W, 5%	R1044
R10	Resistor, 1 K, 1/4 W, 5%	R0765
R11	Resistor, 470 Ω, 1/4 W, 5%	R1044
R12	Resistor, 330 Ω, 1/4 W, 5%	R0662
	Extractor	H1743
	Roll Pin	H1083
	Extractor, Hot Stamp, A4	A39842-4

* * * * * * * * * * * * * * * * *

OPTION 42 FINAL ASSEMBLY PARTS LIST

Ref.	Description	SD Part No.
1	Option 42 Final Assembly	C45401
	ADD	
A4	See 100 MHz Multiplier P.C. Assembly	B39363
	DELETE	
C22	Capacitor, 680 pF	C0736
10	Switch Stop Bracket	39933

ADDENDUM

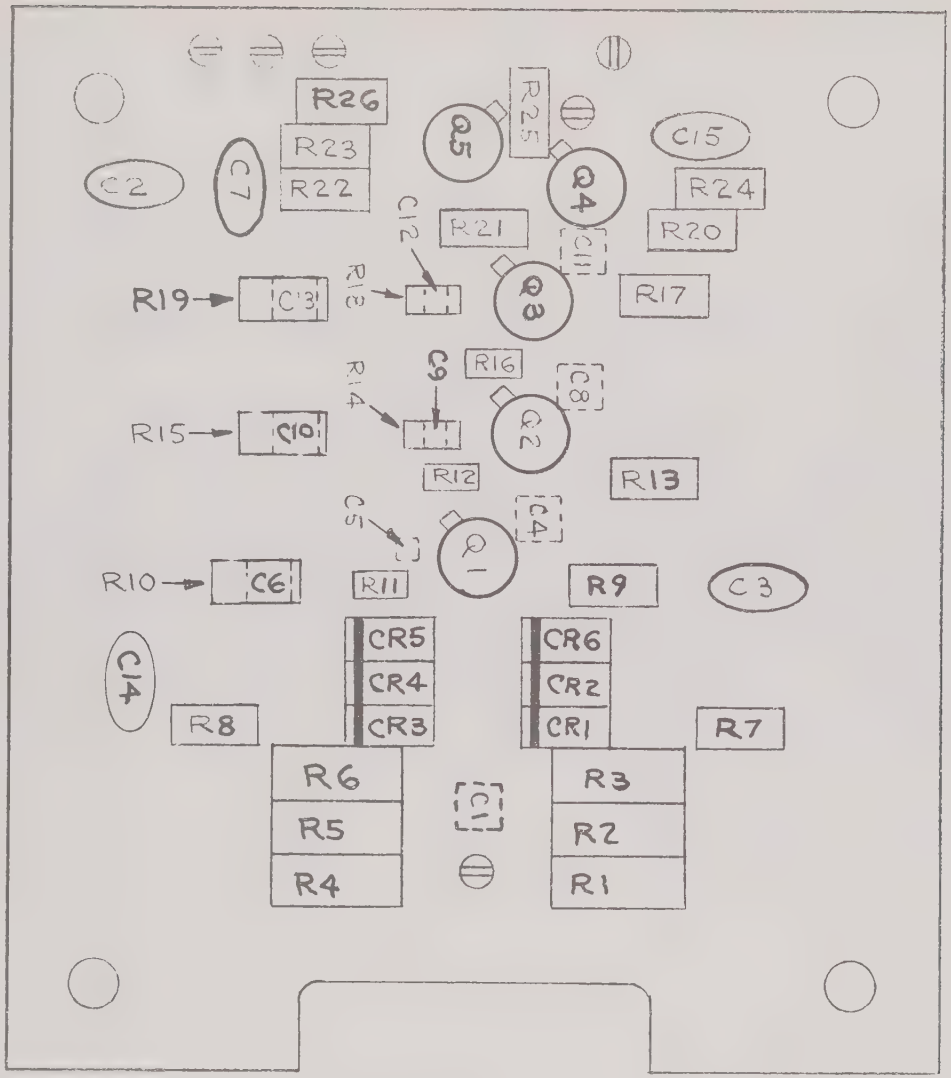
MODEL 6152

The Model 6152 Counter/Timer is identical to the Model 6153-50 described in this manual with the following exceptions:

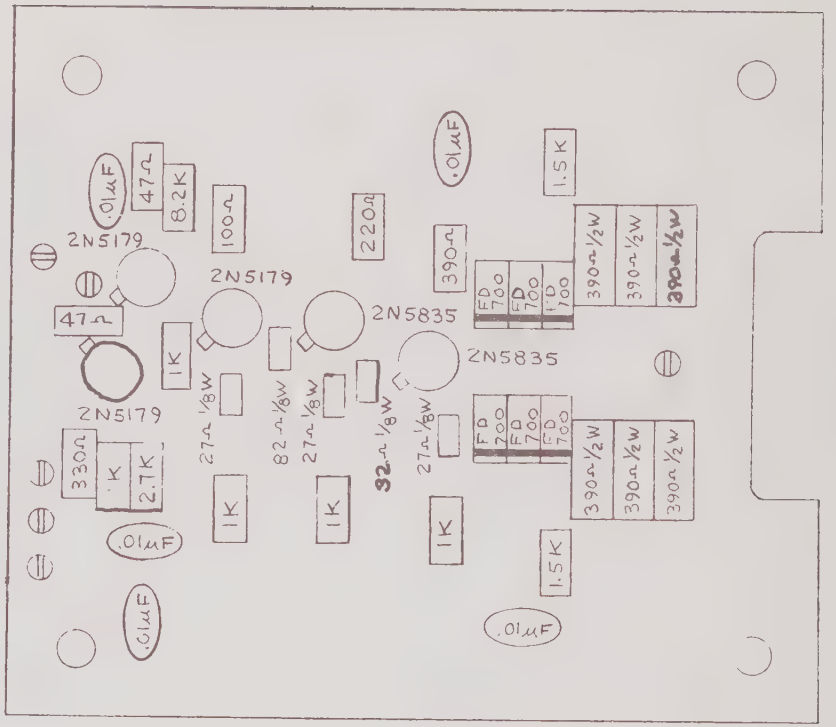
1. The D INPUT Type N connector is removed and replaced by a BNC connector.
2. The D INPUT RANGE is 500 MHz maximum.
3. A20, A14, and A15 assemblies have been replaced along with the block diagram.
4. Unless Option 42 has been included the TIM and PERIOD measurement resolution is 100 nsec.
5. The following drawings have been included:

Model 6152 Block Diagram	E39839R2
500 MHz Input Assembly (2 sheets)	B39771A
500 MHz Input Schematic	B39768A
500 MHz Input Parts List (2 sheets)	P/L 39771A
500 MHz Prescaler Assembly (3 sheets)	B39737A
500 MHz Prescaler Schematic	C39734A
500 MHz Prescaler Parts List (3 sheets)	P/L 39737A
Time Base Expander Assembly	B39742A
Time Base Expander Schematic	B39739A
Time Base Expander Parts List	P/L 39742A

DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION
Chief, McClellan Sector Field Office
5839 - 22nd Street
Rio Linda, California 95673



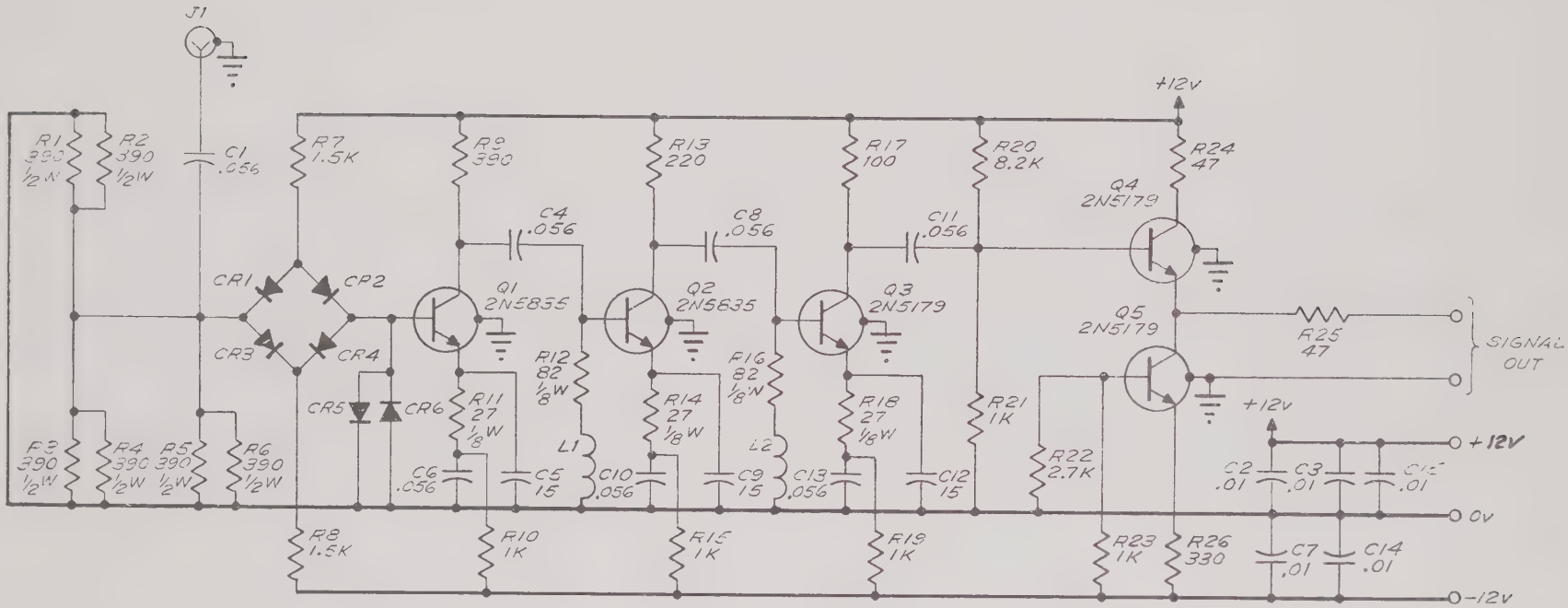
(A20) 500 MHz INPUT ASSEMBLY (Sheet 1 of 2) B39771A



NOTES:

1) UNLESS OTHERWISE SPECIFIED:
   ALL RESISTORS ARE 1/4W 5%
2) MASK OFF CHIP CAPACITOR MTG
   PADS BEFORE MACHINE SOLDERING
3) USE CONDUCTIVE CEMENT TO MOUNT
   CHIP CAPACITORS (ECOBAND 56C OR EQUIV)
   CURE MIN 2 HRS AT 55°C

(A20) 500 MHz INPUT ASSEMBLY (Sheet 2 of 2) B39771A



NOTE: (EXCEPT AS NOTED)

1) RESISTORS - 1/4 W, 5% IN OHMS.
2) CAPACITORS LESS THAN ONE IN μF.
   MORE " " " pF.
3) DIODES ARE FD700.
4) L1 & L2 ARE PART PC PATTERN.

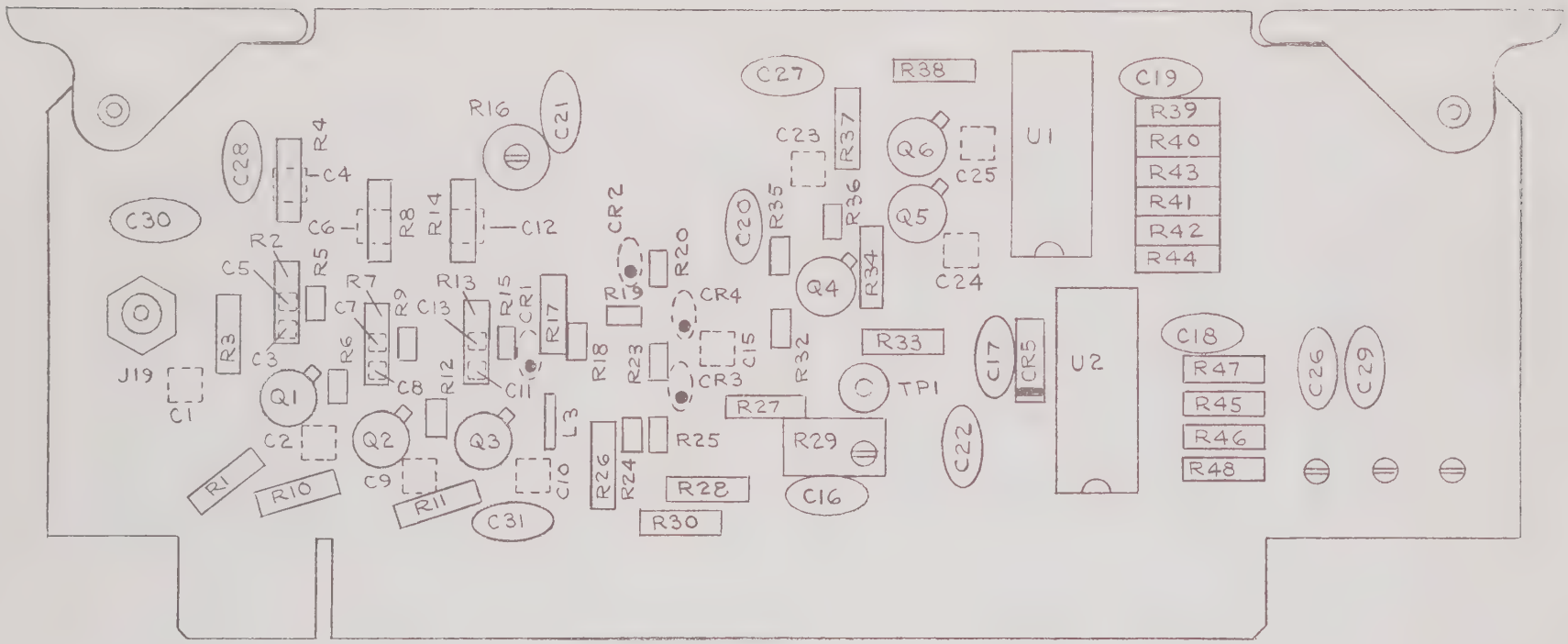
(A20) 500 MHz INPUT SCHEMATIC B39768A

A20, 500 MHz INPUT PARTS LIST

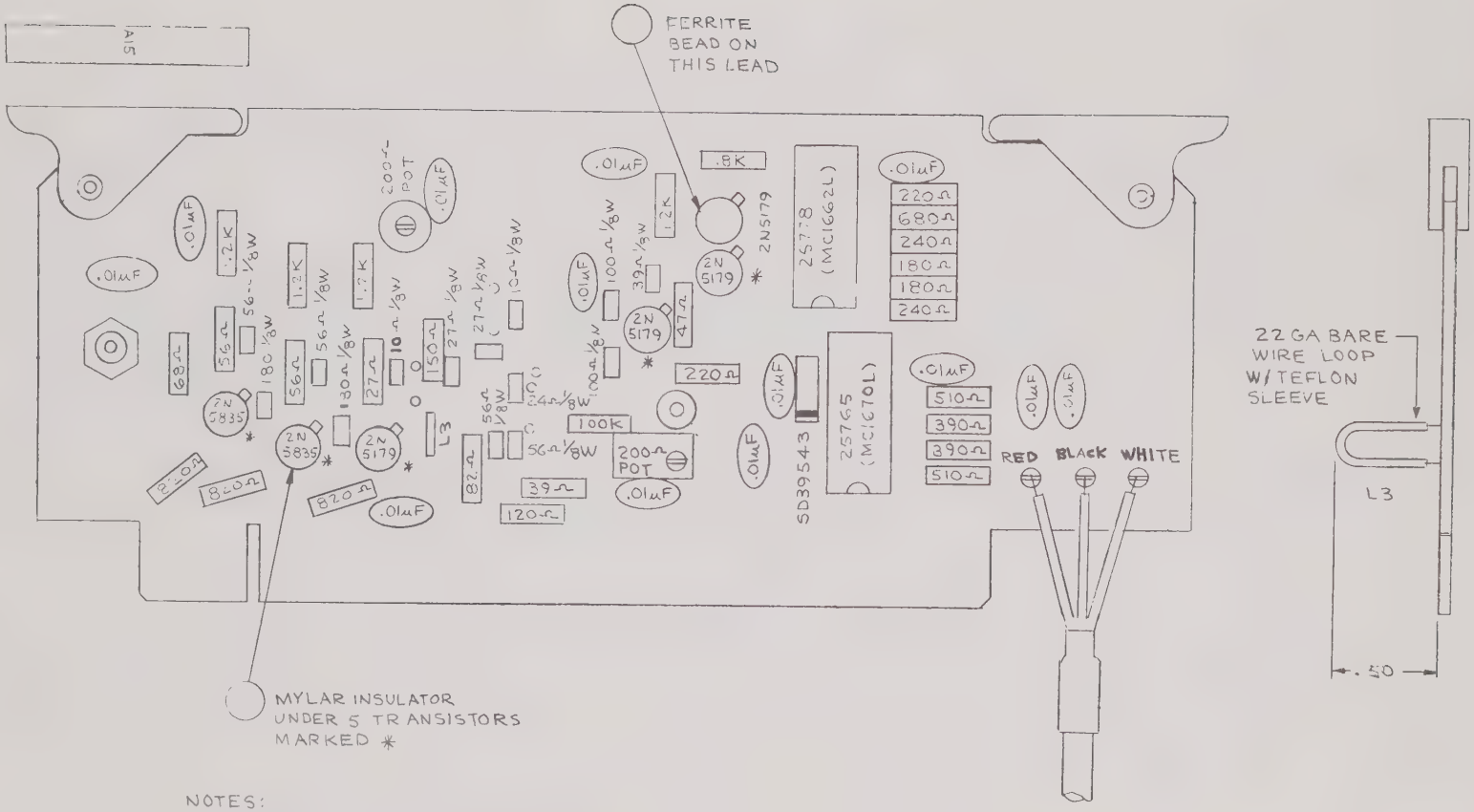
Ref.	Description	SD Part No.
	500 MHz Input Assembly	B39771A
	500 MHz Input Schematic	C39769A
C1	Capacitor, .056 µF, Chip	C1164
C2	Capacitor, .01 µF, 100 V	C0556
C3	Capacitor, .01 µF, 100 V	C0556
C4	Capacitor, .056 µF, Chip	C1164
C5	Capacitor, 15 pF, Chip	C1163
C6	Capacitor, .056 µF, Chip	C1164
C7	Capacitor, .01 µF, 100 V	C0556
C8	Capacitor, .056 µF, Chip	C1164
C9	Capacitor, 15 pF, Chip	C1163
C10	Capacitor, .056 µF, Chip	C1164
C11	Capacitor, .056 µF, Chip	C1164
C12	Capacitor, 15 pF, Chip	C1163
C13	Capacitor, .056 µF, Chip	C1164
C14	Capacitor, .01 µF, 100 V	C0556
C15	Capacitor, .01 µF, 100 V	C0556
CR1	Diode, FD 700	CR0356
CR2	Diode, FD 700	CR0356
CR3	Diode, FD 700	CR0356
CR4	Diode, FD 700	CR0356
CR5	Diode, FD 700	CR0356
CR6	Diode, FD 700	CR0356
Q1	Transistor, 2N5835	Q0307
Q2	Transistor, 2N5835	Q0307
Q3	Transistor, 2N5179	Q0269
Q4	Transistor, 2N5179	Q0269
Q5	Transistor, 2N5179	Q0269
R1	Resistor, 390 Ω, 1/2 W, 5%	R0322
R2	Resistor, 390 Ω, 1/2 W, 5%	R0322
R3	Resistor, 390 Ω, 1/2 W, 5%	R0322
R4	Resistor, 390 Ω, 1/2 W, 5%	R0322
R5	Resistor, 390 Ω, 1/2 W, 5%	R0322
R6	Resistor, 390 Ω, 1/2 W, 5%	R0322
R7	Resistor, 1.5 k, 1/4 W, 5%	R0783
R8	Resistor, 1.5 k, 1/4 W, 5%	R0783
R9	Resistor, 390 Ω, 1/4 W, 5%	R0880
R10	Resistor, 1 k, 1/4 W, 5%	R0765
R11	Resistor, 27 Ω, 1/8 W, 5%	R1825
R12	Resistor, 82 Ω, 1/8 W, 5%	R1745

A20, 500 MHz INPUT PARTS LIST (Cont'd)

Ref.	Description	SD Part No.
R13	Resistor, 220 Ω, 1/4 W, 5%	R0760
R14	Resistor, 27 Ω, 1/8 W, 5%	R1825
R15	Resistor, 1 k, 1/4 W, 5%	R0765
R16	Resistor, 82 Ω, 1/8 W, 5%	R1745
R17	Resistor, 100 Ω, 1/4 W, 5%	R0966
R18	Resistor, 27 Ω, 1/8 W, 5%	R1825
R19	Resistor, 1 k, 1/4 W, 5%	R0765
R20	Resistor, 8.2 k, 1/4 W, 5%	R0883
R21	Resistor, 1 k, 1/4 W, 5%	R0765
R22	Resistor, 2.7 k, 1/4 W, 5%	R0937
R23	Resistor, 1 k, 1/4 W, 5%	R0765
R24	Resistor, 47 Ω, 1/4 W, 5%	R0743
R25	Resistor, 47 Ω, 1/4 W, 5%	R0743
R26	Resistor, 330 Ω, 1/4 W, 5%	R0662

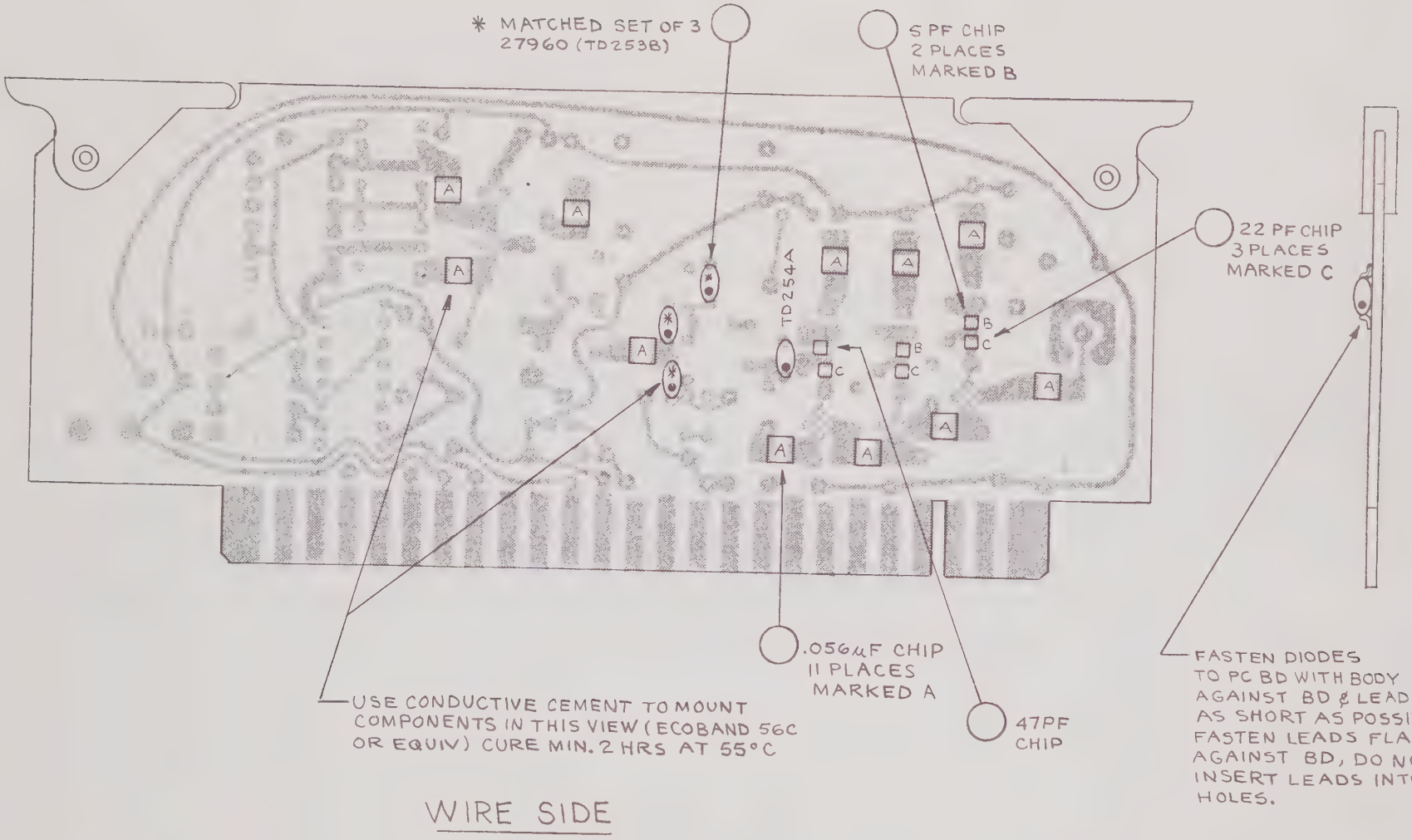


(A15) 500 MHz PRESCALER ASSEMBLY (Sheet 1 of 3) B39737A



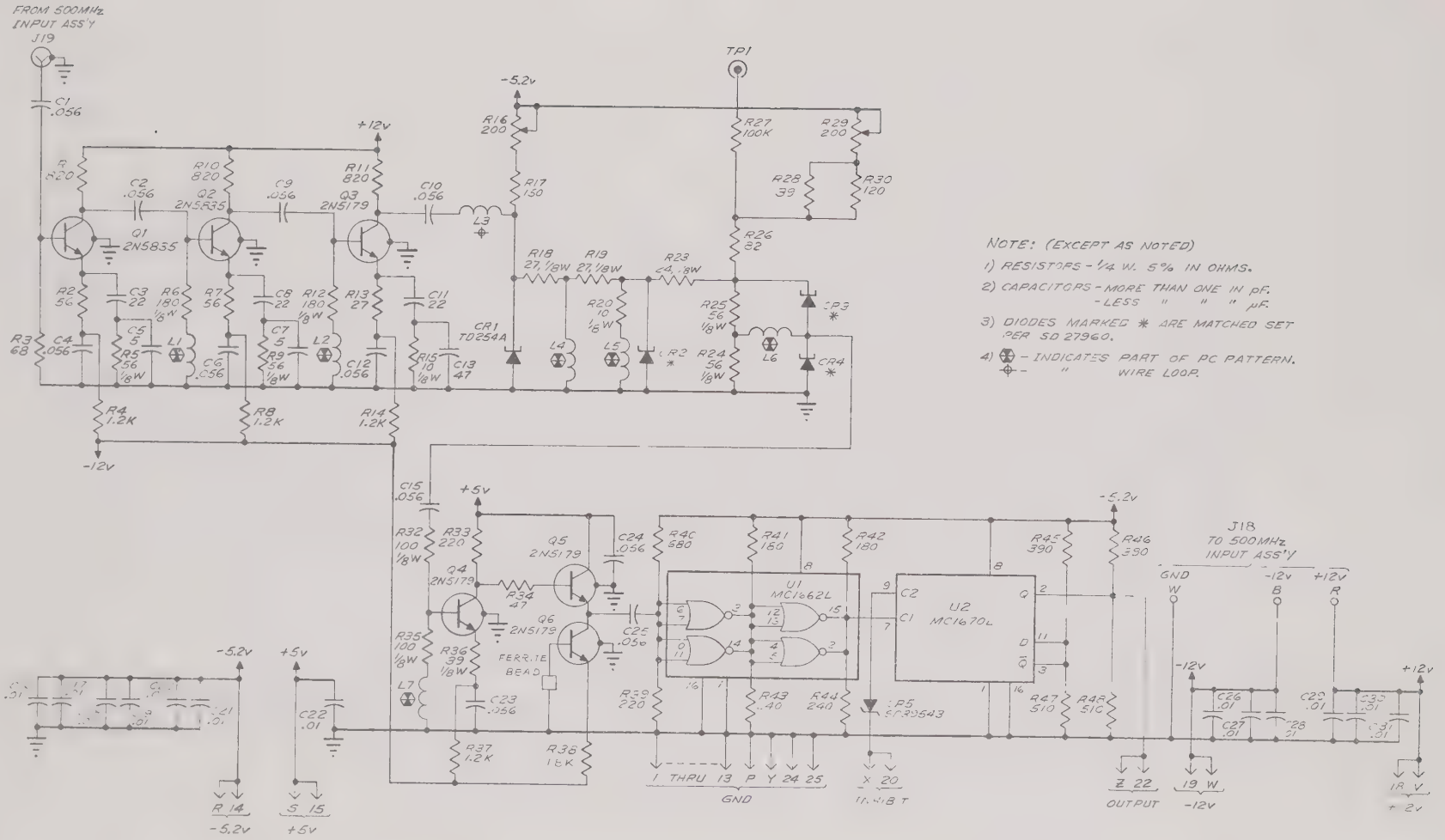
NOTES:
1) UNLESS OTHERWISE SPECIFIED ALL RESISTORS ARE 1/4W 5%
2) MASK CONNECTIONS OF WIRE SIDE COMPONENTS BEFORE MACHINE SOLDERING. (SEE SHEET 3 OF 3)

(A15) 500 MHz PRESCALER ASSEMBLY (Sheet 2 of 3) B39737A



WIRE SIDE

(A15) 500 MHz PRESCALER ASSEMBLY (Sheet 3 of 3) B39737A



NOTE: (EXCEPT AS NOTED)

1) RESISTORS - 1/4 W. 5% IN OHMS.
2) CAPACITORS - MORE THAN ONE IN pF.
   - LESS " " " µF.
3) DIODES MARKED * ARE MATCHED SET PER SD 27960.
4) ⊕ - INDICATES PART OF PC PATTERN.
   ⊕ - " WIRE LOOP.

(A15) 500 MHz PRESCALER SCHEMATIC C39734A

A15, 500 MHz PRESCALER PARTS LIST

Ref.	Description	SD Part No.
	500 MHz Prescaler Assembly	B39737A
	500 MHz Prescaler Schematic	B39734A
C1	Capacitor, .056 µF, Chip	C1164
C2	Capacitor, .056 µF, Chip	C1164
C3	Capacitor, 22 pF, Chip	C1177
C4	Capacitor, .056 µF, Chip	C1164
C5	Capacitor, 5 pF, Chip	C1187
C6	Capacitor, .056 µF, Chip	C1164
C7	Capacitor, 5 pF, Chip	C1187
C8	Capacitor, 22 pF, Chip	C1177
C9	Capacitor, .056 µF, Chip	C1164
C10	Capacitor, .056 µF, Chip	C1164
C11	Capacitor, 22 pF, Chip	C1177
C12	Capacitor, .056 µF, Chip	C1164
C13	Capacitor, 47 pF, Chip	C1269
C14	Not Used	
C15	Capacitor, .056 µF, Chip	C1164
C16	Capacitor, .01 µF, 100 V	C0556
C17	Capacitor, .01 µF, 100 V	C0556
C18	Capacitor, .01 µF, 100 V	C0556
C19	Capacitor, .01 µF, 100 V	C0556
C20	Capacitor, .01 µF, 100 V	C0556
C21	Capacitor, .01 µF, 100 V	C0556
C22	Capacitor, .01 µF, 100 V	C0556
C23	Capacitor, .056 µF, Chip	C1164
C24	Capacitor, .056 µF, Chip	C1164
C25	Capacitor, .056 µF, Chip	C1164
C26	Capacitor, .01 µF, 100 V	C0556
C27	Capacitor, .01 µF, 100 V	C0556
C28	Capacitor, .01 µF, 100 V	C0556
C29	Capacitor, .01 µF, 100 V	C0556
C30	Capacitor, .01 µF, 100 V	C0556
C31	Capacitor, .01 µF, 100 V	C0556
CR1	Diode, TD254A	CR0360
CR2	Diode, Matched Set	A27960
CR3	Diode, Matched Set	A27960
CR4	Diode, Matched Set	A27960
CR5	Diode, SD39543	A39543
J19	Connector, Coax, PC Mtg.	J0628

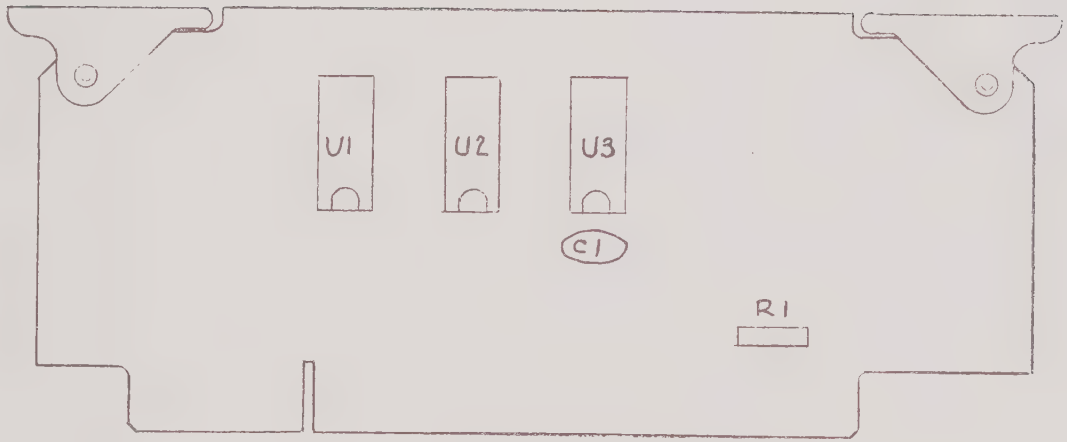
A15, 500 MHz PRESCALER PARTS LIST (Cont'd)

Ref.	Description	SD Part No.
Q1	Transistor, 2N5835	Q0307
Q2	Transistor, 2N5835	Q0307
Q3	Transistor, 2N5179	Q0269
Q4	Transistor, 2N5179	Q0269
Q5	Transistor, 2N5179	Q0269
Q6	Transistor, 2N5179	Q0269
R1	Resistor, 820 Ω, 1/4 W, 5%	R0762
R2	Resistor, 56 Ω, 1/4 W, 5%	R1554
R3	Resistor, 68 Ω, 1/4 W, 5%	R1426
R4	Resistor, 1.2 k, 1/4 W, 5%	R0809
R5	Resistor, 56 Ω, 1/8 W, 5%	R1833
R6	Resistor, 180 Ω, 1/8 W, 5%	R1477
R7	Resistor, 56 Ω, 1/4 W, 5%	R1554
R8	Resistor, 1.2 k, 1/4 W, 5%	R0809
R9	Resistor, 56 Ω, 1/8 W, 5%	R1833
R10	Resistor, 820 Ω, 1/4 W, 5%	R0762
R11	Resistor, 820 Ω, 1/4 W, 5%	R0762
R12	Resistor, 180 Ω, 1/8 W, 5%	R1477
R13	Resistor, 27 Ω, 1/4 W, 5%	R1548
R14	Resistor, 1.2 k, 1/4 W, 5%	R0809
R15	Resistor, 10 Ω, 1/8 W, 5%	R1866
R16	Resistor, 200 Ω, Potentiometer	R2394
R17	Resistor, 150 Ω, 1/4 W, 5%	R0983
R18	Resistor, 27 Ω, 1/8 W, 5%	R1825
R19	Resistor, 27 Ω, 1/8 W, 5%	R1825
R20	Resistor, 10 Ω, 1/8 W, 5%	R1866
R21	Not Used	
R22	Not Used	
R23	Resistor, 24 Ω, 1/8 W, 5%	R1824
R24	Resistor, 56 Ω, 1/8 W, 5%	R1833
R25	Resistor, 56 Ω, 1/8 W, 5%	R1833
R26	Resistor, 82 Ω, 1/4 W, 5%	R1059
R27	Resistor, 100 k, 1/4 W, 5%	R0741
R28	Resistor, 39 Ω, 1/4 W, 5%	R1552
R29	Resistor, 200 Ω, Potentiometer	R2425
R30	Resistor, 120 Ω, 1/4 W, 5%	R1461
R31	Not Used	
R32	Resistor, 100 Ω, 1/8 W, 5%	R1441
R33	Resistor, 220 Ω, 1/4 W, 5%	R0760
R34	Resistor, 47 Ω, 1/4 W, 5%	R0743
R35	Resistor, 100 Ω, 1/8 W, 5%	R1441

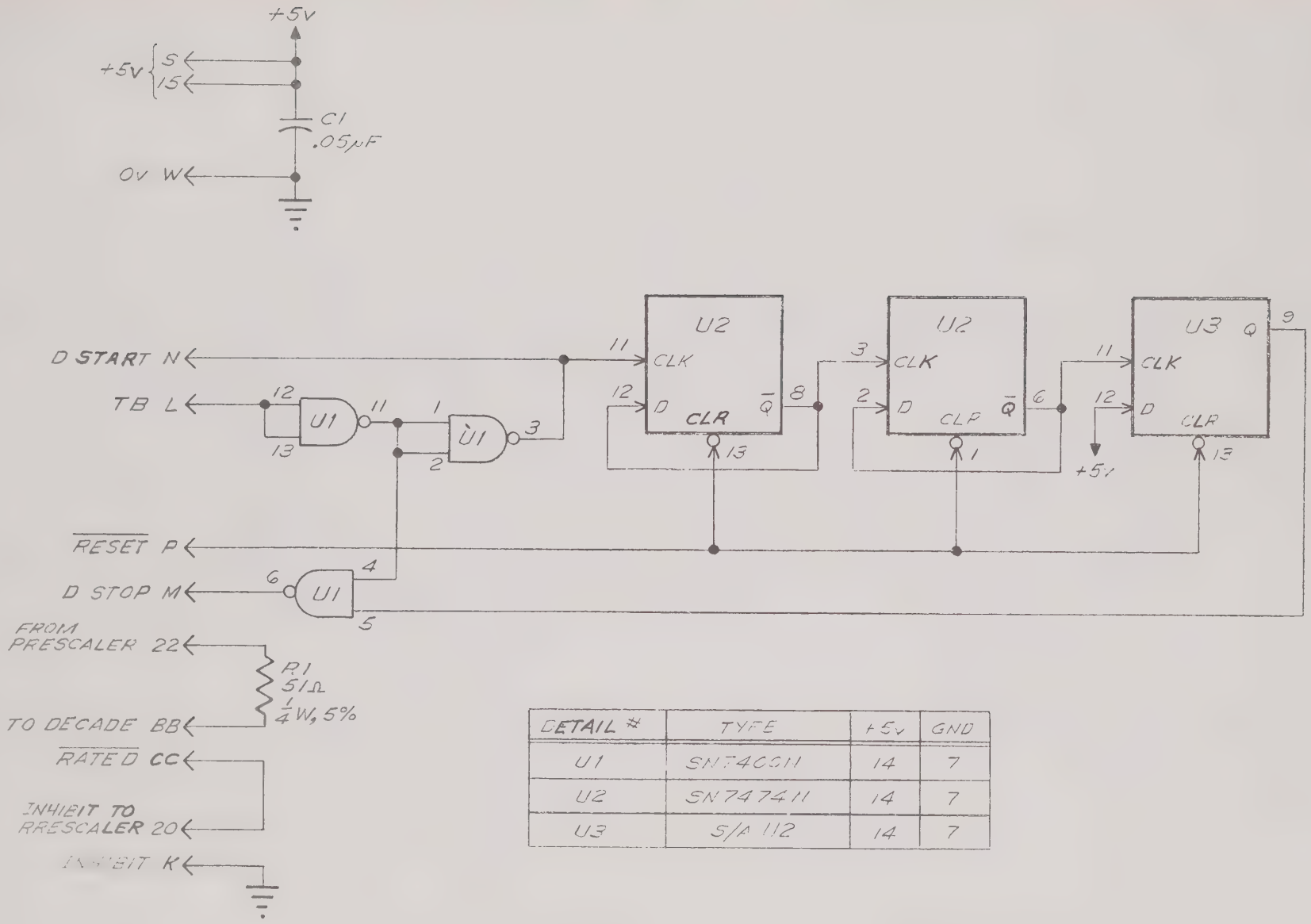
A15, 500 MHz PRESCALER PARTS LIST (Cont'd)

Ref.	Description	SD Part No.
R36	Resistor, 39 Ω, 1/8 W, 5%	R1829
R37	Resistor, 1.2 k, 1/4 W, 5%	R0809
R38	Resistor, 1.8 k, 1/4 W, 5%	R0959
R39	Resistor, 220 Ω, 1/4 W, 5%	R0760
R40	Resistor, 680 Ω, 1/4 W, 5%	R1234
R41	Resistor, 180 Ω, 1/4 W, 5%	R1233
R42	Resistor, 180 Ω, 1/4 W, 5%	R1233
R43	Resistor, 240 Ω, 1/4 W, 5%	R0835
R44	Resistor, 240 Ω, 1/4 W, 5%	R0835
R45	Resistor, 390 Ω, 1/4 W, 5%	R0880
R46	Resistor, 390 Ω, 1/4 W, 5%	R0880
R47	Resistor, 510 Ω, 1/4 W, 5%	R0984
R48	Resistor, 510 Ω, 1/4 W, 5%	R0984
TP1	Test Point, Brown	E0284
U1	Integrated Circuit, MC1662L	25778
U2	Integrated Circuit, MC1670L	25765

NOTES



(A14) TIME BASE EXPANDER ASSEMBLY B39742A

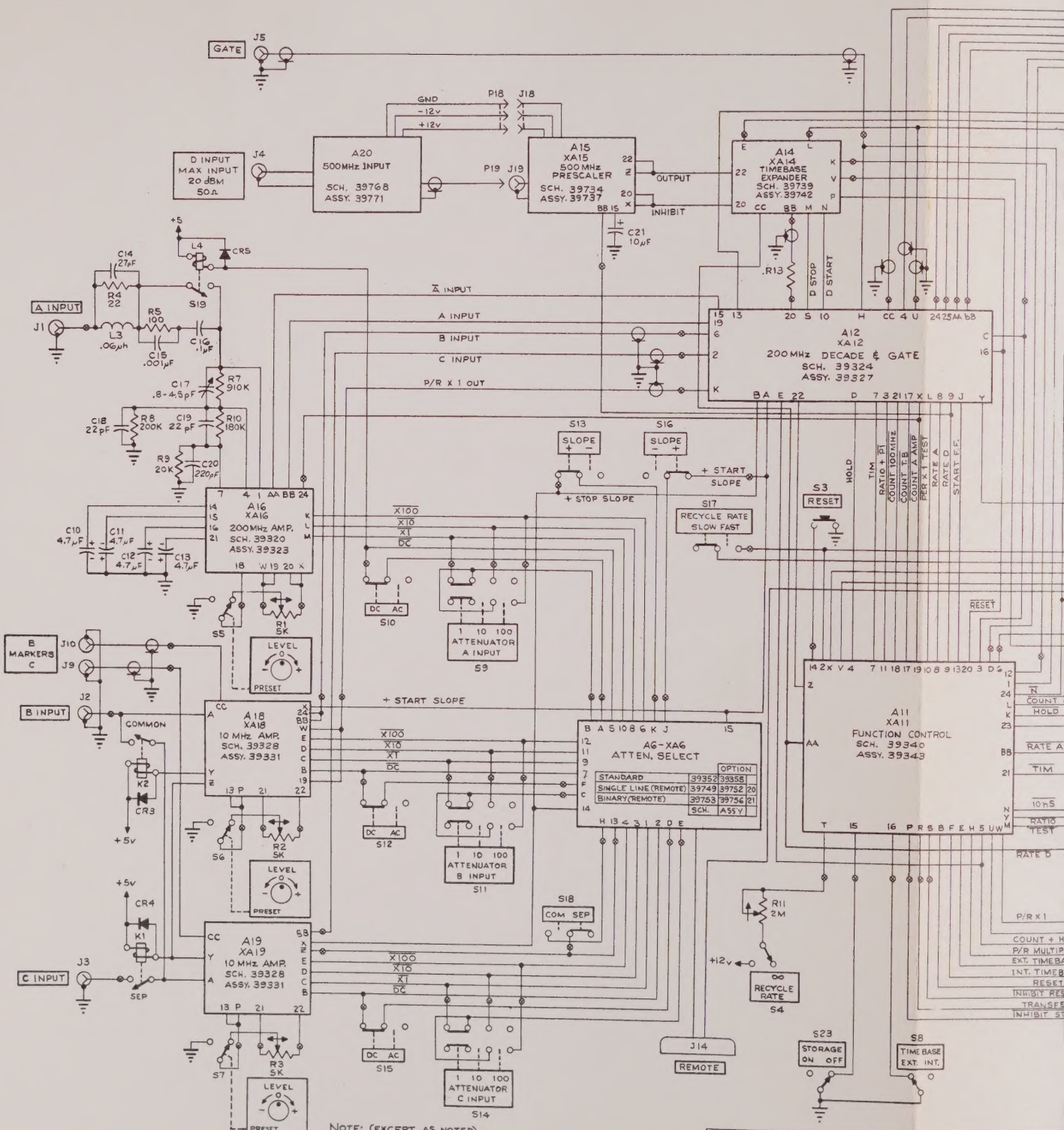


DETAIL #	TYPE	+5v	GND
U1	SN7400N	14	7
U2	SN 74 74 N	14	7
U3	S/A 112	14	7

(A14) TIME BASE EXPANDER SCHEMATIC B39739A

A14, TIME BASE EXPANDER PARTS LIST

Ref.	Description	SD Part No.
	Time Base Expander Assembly	B39742A
	Time Base Expander Schematic	B39739A
C1	Capacitor, .05 µF, 12 V	C0672
R1	Resistor, 51 Ω, 1/4 W, 5%	R1246
U1	Integrated Circuit, SN7400N	19705
U2	Integrated Circuit, SN7474N	25241
U3	Integrated Circuit, SN7474N	25241



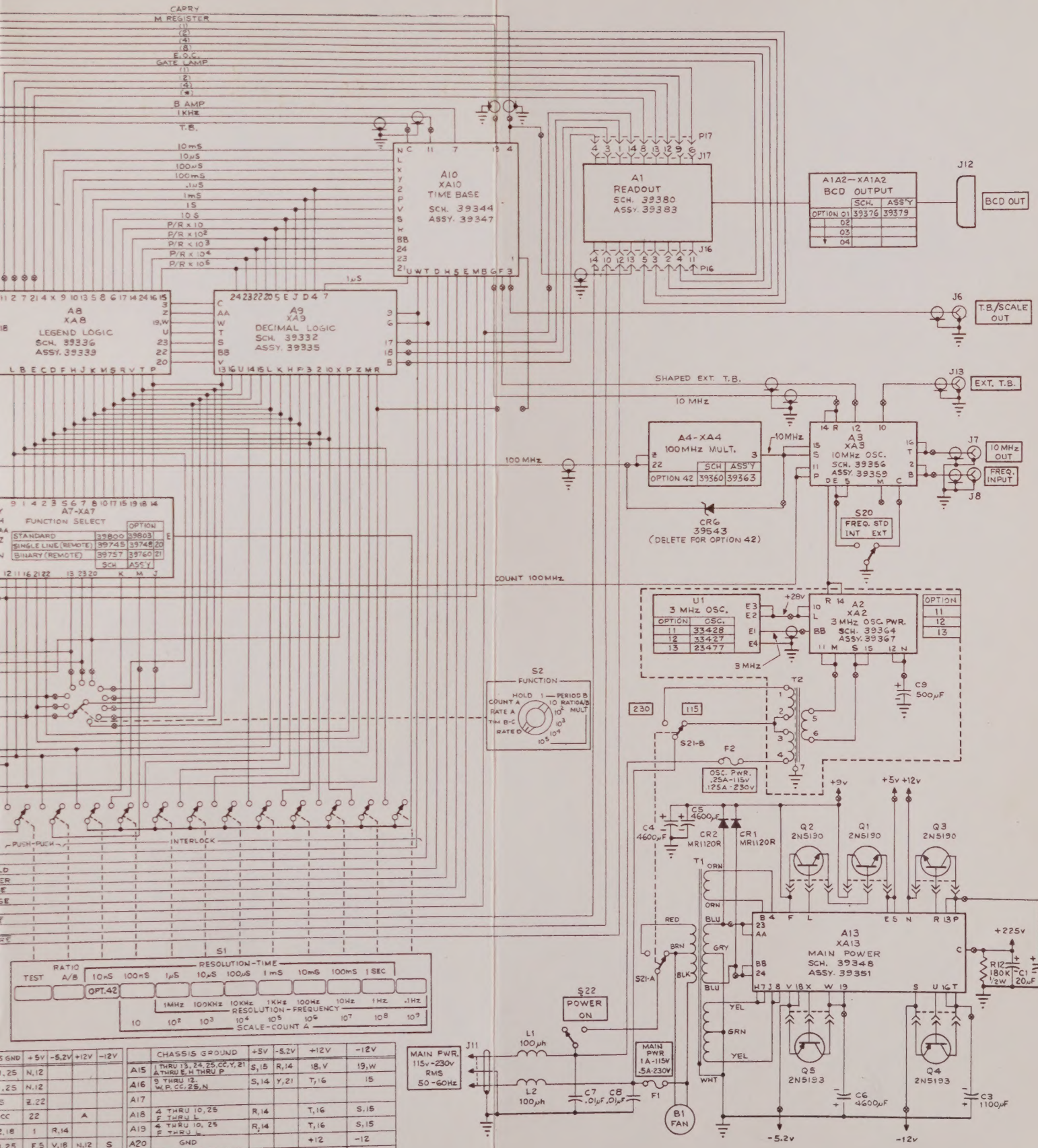
NOTE: (EXCEPT AS NOTED)

1) RESISTORS: VALUE IN OHMS. POWER 1/4 W. TOL. 5%.

2) —⊗— DENOTES WIRE CONNECTIONS TO MOTHER PC BOARD.

	CHASSIS GROUND	+9v	+5v	-5.2v	+12v	-12v	+225v
A1	7, 8 (J16)	10(J17)	6,9 (J16)		1(J16)		7(J17)
A2	AA, CC, U, 23, 25		W, 19				
A3	BB, CC, 24, 25		X, 20		V, 18	U, 17	
A4	A, B, N, P, AA, BB, CC, 1, 2, 12, 13, 23, 24, 25		W	Y			
A5							
A6	CC, 25		BB				
A7	CC, 25		BB				

	CHASS
A8	A, CC
A9	A, CC
A10	A, CC
A11	25
A12	Y, N,
A13	A, CC
A14	A, W, X, 1, 21, 23



	CHASSIS GROUND	+5V	-5.2V	+12V	-12V
A15	1 THRU 13, 24, 25, CC, Y, 21 A THRU E, H THRU P	S, 15	R, 14	18, V	19, W
A16	9 THRU 12, W, P, CC, 25, N	S, 14	Y, 21	T, 16	15
A17					
A18	4 THRU 10, 25 F THRU L	R, 14		T, 16	S, 15
A19	4 THRU 10, 25 F THRU L	R, 14		T, 16	S, 15
A20	GND			+12	-12
A1A2	28	FF		4	

S GND	+5V	-5.2V	+12V	-12V
.25	N, 12			
.25	N, 12			
S	Z, 22			
CC	22		A	
2, 18	1	R, 14		
.25	E, 5	V, 18	N, 12	S
Z AA, 24 25	15, S	R, 14		

BLOCK DIAGRAM MODEL 6152 E39839R2